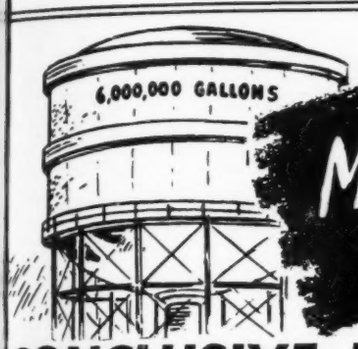
WATER WORKS & SEWERAGE

A GILLETTE ABP ABC PUBLICATION

Vol. 86, No. 10 OCTOBER, 1939 L. H. Enslow Editor



Measured 6 million gallons— Repair cost only 44¢

CONCLUSIVE PROOF THAT PITTSBURGH LMC METERS WEAR IN WHERE OTHERS WEAR OUT!

An endurance test recently conducted by a large Midwestern Waterworks department conclusively proved that Pittsburgh IMO Meters will lower maintenance costs by reducing the frequency and expense of meter repairs.

On this particular run the IMO measured 6,000,000 gallons at variable flow rates before completion of the test. Figuring a good average yearly consumption of water on a domestic service to be 60,000 gallons, the amount of water registered would be equivalent to about 100 years of service.

Examination of the meter after the test showed not even slight wear evidenced on the meshing surfaces of the three rotor screws. Only one part of the meter was sufficiently worn to justify replacement, and this item only cost 44 cents. After this replacement was made the meter was then given the usual factory accuracy test for new meters, with the following results:

20 G.P.M.— 99.0%
1 G.P.M.—101.0%
1/4 G.P.M.— 96.5%
1/12 G.P.M.— 80.0%

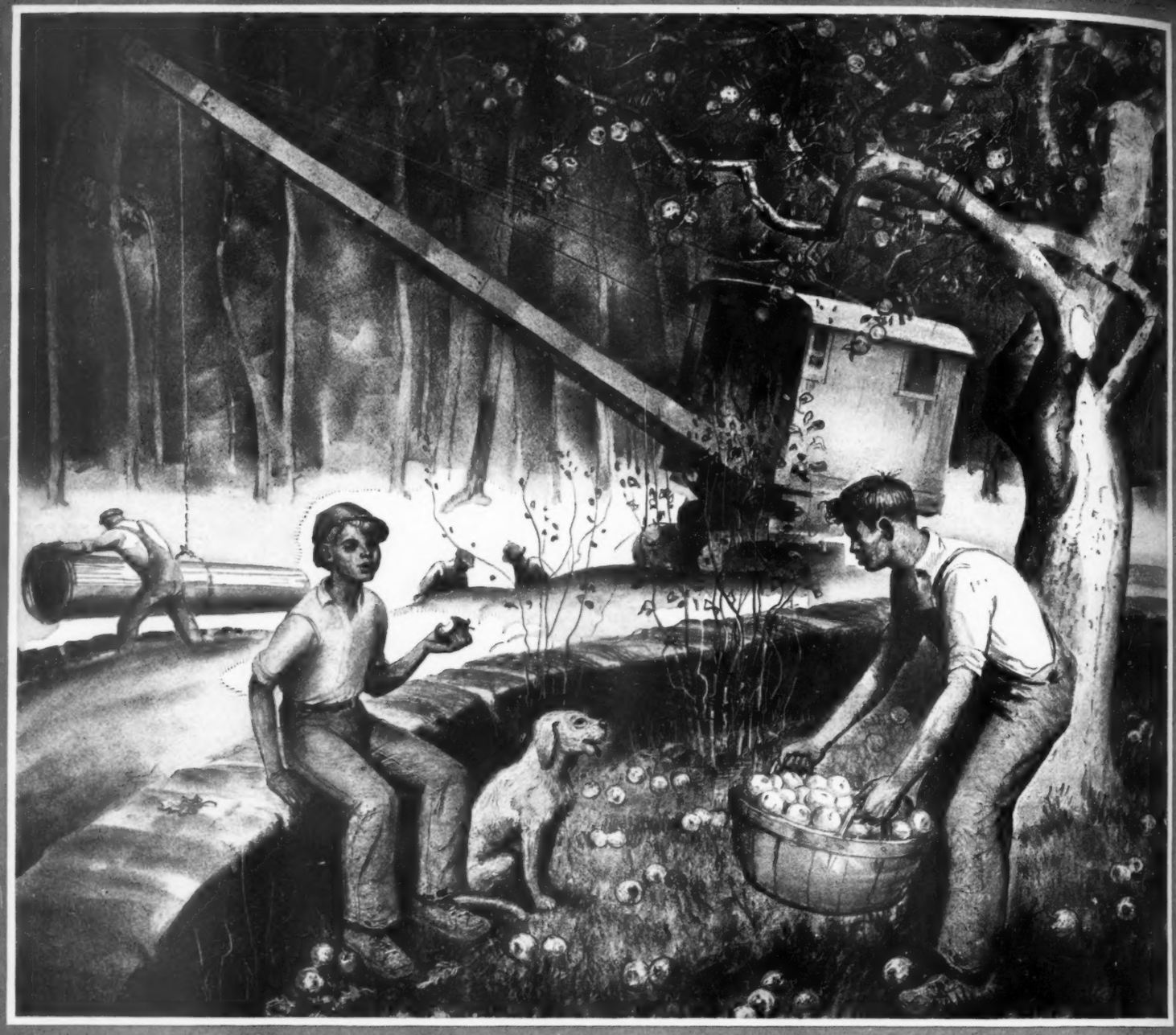
This showing, while not up to new IMO meter standards, was still better than the accuracy requirements imposed on the best new disc meters.

If the old saying, "The First Hundred Years Are The Hardest," still holds true, the Pittsburgh IMO will save Waterworks men thousands of dollars through its longer life and its ability to accurately measure extremely low flows. The whole story is told in Bulletin W-529. Write for your copy today.

PITTSBURGH LMC FEATURES

LOW FLOW ACCURACY
SUSTAINED ACCURACY
SILENT OPERATION
LONGER LIFE
LOWER MAINTENANCE

PITTSBURGH EQUITABLE METER COMPANY
MERCO NORDSTROM VALVE CO.
NEW YORK · BUFFALO · PHILADELPHIA · KANSAS CITY · TULSA · LOS ANGELES
Main Offices - PITTSBURGH, PA.
DES MOINES · CHICAGO · COLUMBIA · MEMPHIS · OAKLAND · HOUSTON



Lithographed on stone by James E. Allen, Copyright 1939, U. S. Pipe & Foundry Co.

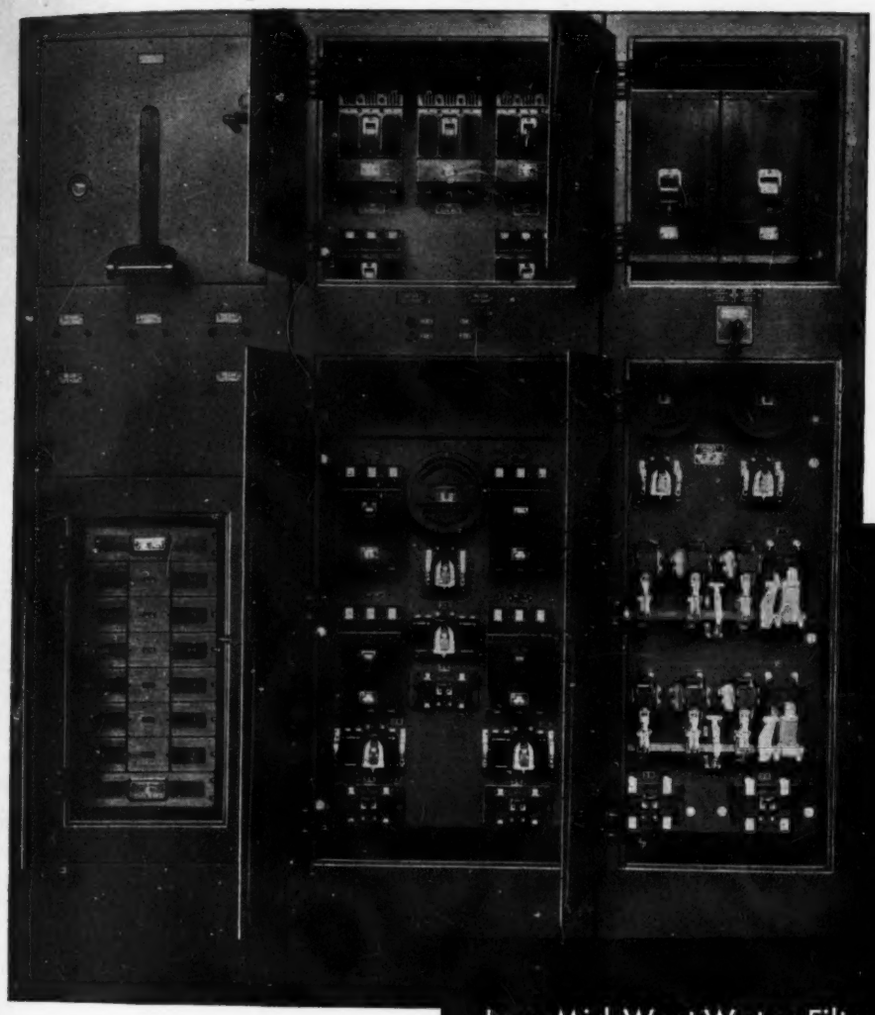
One of the fruits of Research is Super-de Lavaud Pipe which we cast centrifugally in a metal mold by a patented chill-free process. Developed in our laboratory eight years ago, Super-de Lavaud Cast Iron Pipe has long since demonstrated its great toughness, ductility and impact strength.

U.S.
cast iron
PIPE

United States Pipe & Foundry Co., Burlington, N. J.

Plants and Sales offices throughout the United States.

NEAT, EFFECTIVE CONTROL



Open view, Special 3 Section, Dead Front, Enclosed, Floor Mounted Switchboard. It houses Incoming Line, Lighting Distribution, and Motor Control for 2 Low Lift, 2 High Lift, and 1 Washwater Pump Motors. All motors are 220 volt, 3 phase, 60 cycle.

In a Mid-West Water Filtration Plant, this "3C" Panel provides maximum safety with extreme neatness. With doors closed, the entire front is "dead," and arrangements for locking are provided on each door, so that unauthorized persons may not tamper.

Shown above are the "3C" Overload Relays, Contactors, Pressure Regulators, Push Buttons, etc. that give unexcelled motor protection.

A folder describing many "3C" Sewage Disposal Plant and Water Works installations is yours on request.

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

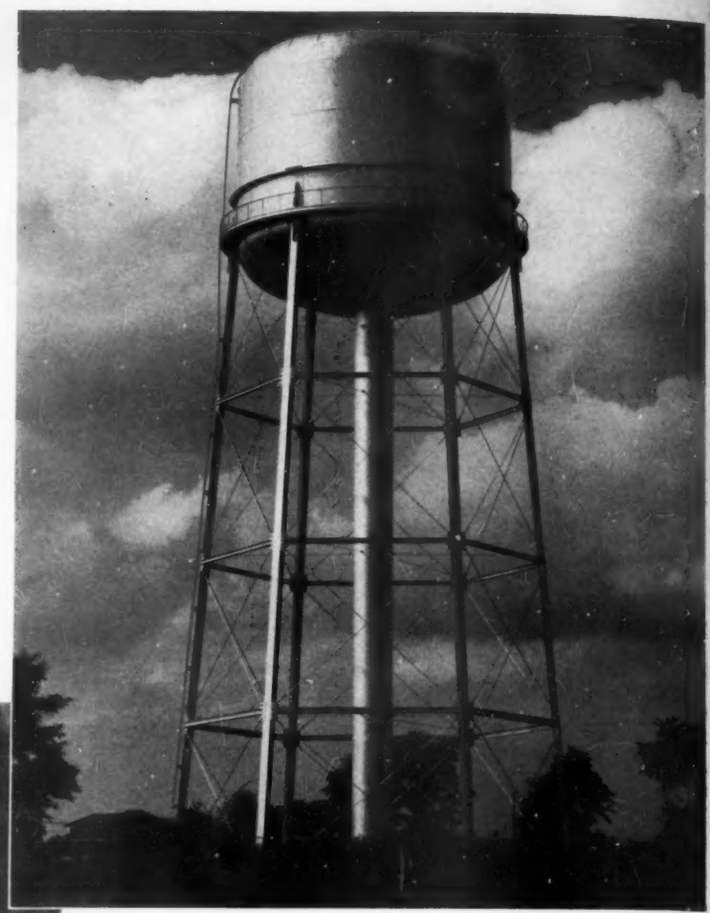
1146 EAST 152ND ST. CLEVELAND, OHIO

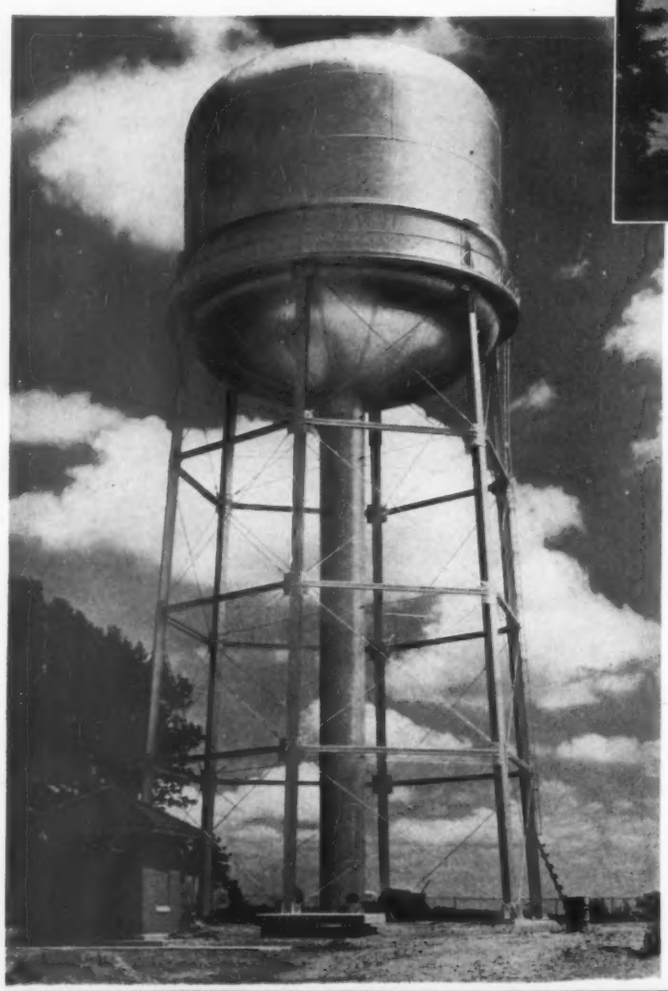
WATER WORKS AND SEWERAGE, October, 1939. Volume 86. Number 10. Published monthly at 330 South Wells Street, Chicago, Ill., by the Gillette Publishing Company. Per copy, 25c. Subscription rate, United States and Canada $2.00 per year; Foreign, $3.00 per year. Copyright, 1939. Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under Act of March 3, 1879.

TWO NEW TANKS

for the Baltimore County Metropolitan District

Right: Elevated tank installed in the Baltimore County Metropolitan District at Pleasant Hill, Md. It has a capacity of 300,000-gals. and is 70 ft. 3 in. to bottom. Below: New Horton ellipsoidal-bottom elevated tank located at Reisterstown, Maryland. It also has a capacity of 300,000-gals., but stands 88 ft. 9 in. to bottom.





THE Metropolitan District of Baltimore County, Maryland, furnishes water for the City of Baltimore and several suburbs of this historically famous city. The waterworks distribution system which serves this large area is divided into five separate "service zones." Each zone is laid out at a different elevation, which necessitates having different types of pumping equipment, storage facilities, etc. At low elevations for example, adequate pressures and supply are obtained from dams, reservoirs and lakes. In zones of higher elevation, however, either standpipes or elevated storage tanks are used to provide the necessary gravity supply. Such is the purpose of the two 300,000-gal. elevated tanks shown here. They were installed to provide the required capacity and pressure in two of the service zones, one of which has just recently been added to the system.

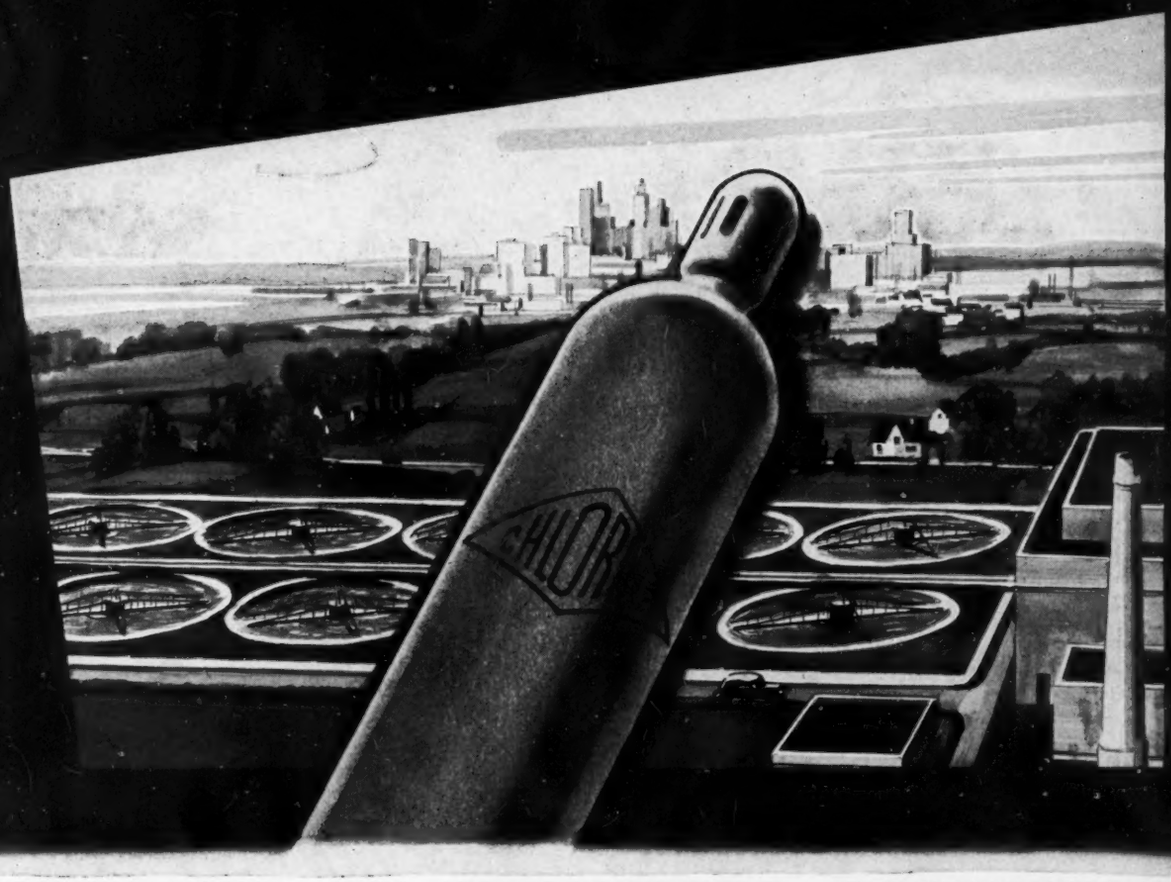
It is interesting to note that after improvements were made in this new zone, including the installation of the elevated tank, insurance rates were cut almost in half on practically all types of houses. For complete information about elevated storage tanks, please address our nearest office.

CHICAGO BRIDGE & IRON COMPANY

Chicago	2198 Old Colony Bldg.	Birmingham	1586 North 50th Street	Philadelphia	1644-1700 Walnut St. Bldg.
New York	3390-165 Broadway Bldg.	Tulsa	1646 Hunt Bldg.	Boston	1548 Consolidated Gas Bldg.
Cleveland	2262 Rockefeller Bldg.	Houston	2919 Main Street	San Francisco	1083 Rialto Bldg.
Dallas	1479 Liberty Bank Bldg.	Detroit	1551 Lafayette Bldg.	Los Angeles	1455 Wm. Fox Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM, and GREENVILLE, PA.

DIAMOND LIQUID CHLORINE

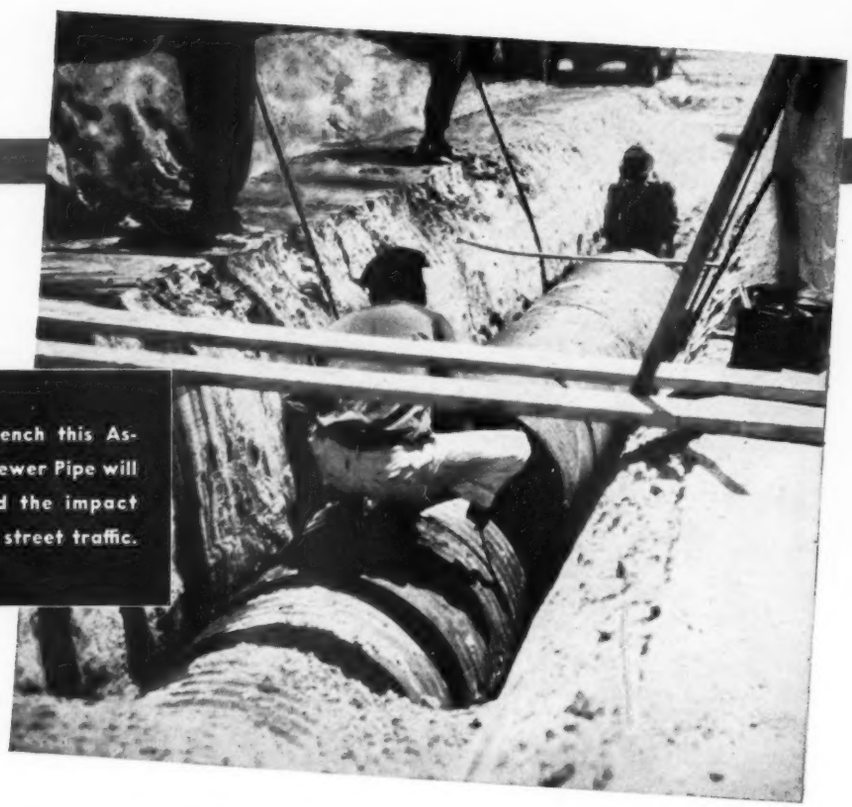


PREFERRED BY MUNICIPAL ENGINEERS!

Because of its absolute purity and year around uniformity Diamond Liquid Chlorine assures positive bacterial control under all conditions of service . . . aids modern sewage disposal . . . prevents disease contamination in public swimming pools. Municipal engineers, too, like the quick and prompt deliveries of Diamond Chlorine in the modern trouble-free containers. Your local Diamond distributor will welcome the opportunity to serve you!

DIAMOND ALKALI COMPANY . . . PITTSBURGH *AND EVERYWHERE*

Here's a Pipe *You Install and Forget*



Placed in a shallow trench this Asbestos-Bonded Armco Sewer Pipe will successfully withstand the impact and vibration of heavy street traffic.

No need to replace broken sections; repair leaky inefficient joints; or remove troublesome tree roots, not when you use Armco Sewer Pipe.

• Years ago when things went "wrong" with sewers, they were taken for granted. But today many engineers feel different; because they realize that the cost of maintenance and sewage treatment can be greatly reduced by using Armco Sewer Pipe.

Here, truly, is one sewer pipe you can install and forget. Neither heavy loads, traffic impact nor splitting frost action will harm it. Then too, thanks to its flexible corrugated iron design and tightly coupled joints, Armco Sewer Pipe holds its grade and alignment in the most unstable soil without admitting tree roots or ground water.

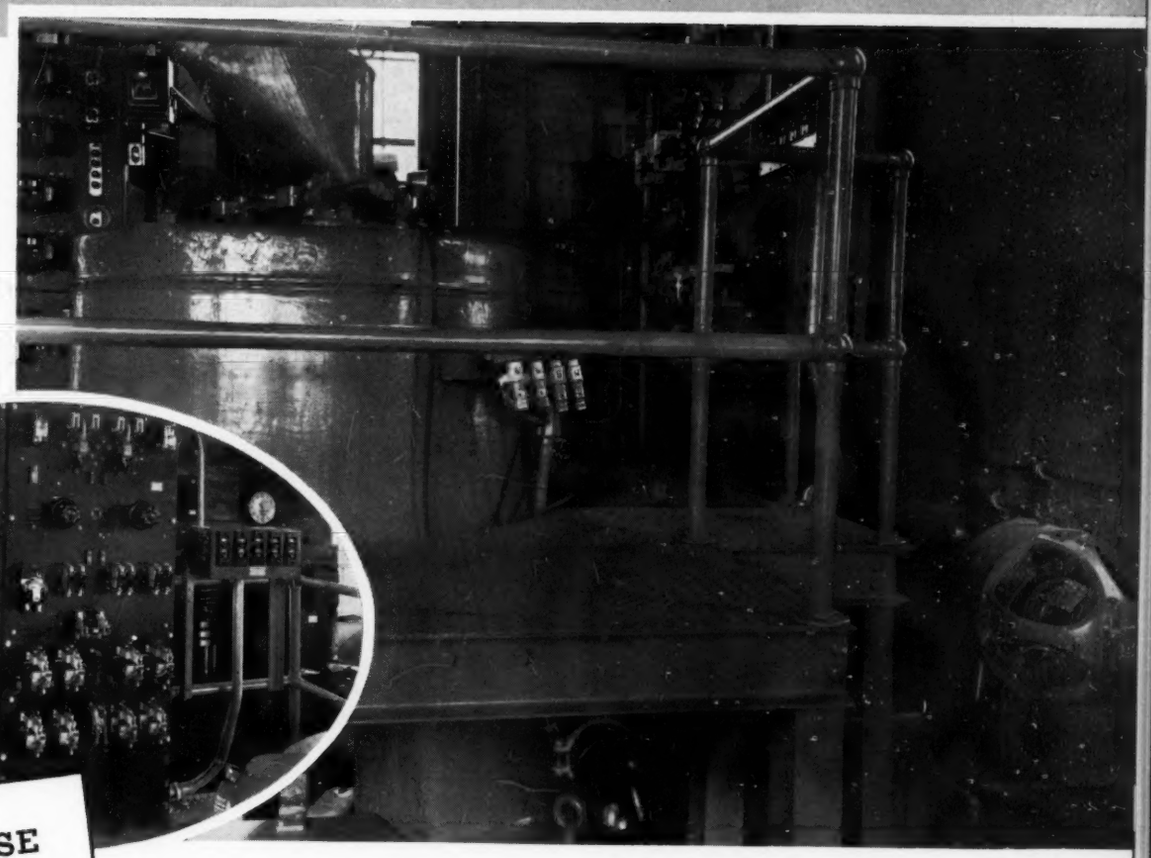
It will serve a long, long time, too, because Armco Sewer Pipe is made of galvanized ARMCO Ingot Iron—proved by 33 years of service. Besides, it's paved in the bottom and fully coated with a special bituminous material securely bonded to the pipe. Write for the 48-page Armco Sewer Book. Armco Culvert Mfrs. Assn., Middletown, Ohio.

ASBESTOS-BONDED ARMCO SEWER PIPE

A PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

45% LESS POWER DEMAND

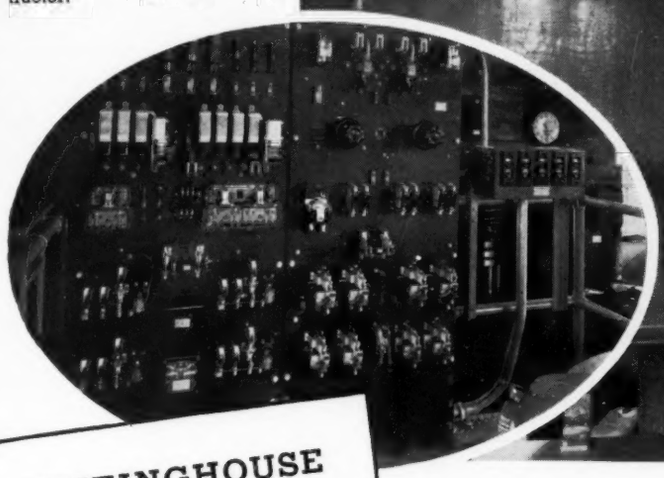
with variable voltage equipment



General view, showing motor generator set at right, control panel at end of operator's platform, and enclosed extractor basket with feeding spout and cutter operating mechanism to the left.

•

Close-up of control panel and operator's push button station, for centrifugal extractor.



WESTINGHOUSE EQUIPMENT INCLUDES:

D-C variable voltage motor generator set, composed of 75 hp induction motor, 50 kw d-c variable voltage generator and a 3 kw, 250 volt d-c exciter.

60 hp 230 volt, 600 to 1,800 rpm shunt wound motor for driving centrifuge.

1½ hp 230 volt, d-c gearmotor with 3 to 1 output speed, for driving cutters.

A-C agitator motor for stirring sewage in feeding tank.

A-C motor for driving belt conveyor.

Automatic control equipment for operating above motors and generators.

At the sewage plant at Elizabeth, New Jersey, an American Centrifuge operated with Westinghouse variable voltage equipment shows marked advance in efficiency, simplicity and operating costs, over an identical alternating current plant. Power demand charges are 45% less, off-peak power rates show saving of 34c per dry ton handled, and on-peak costs deliver similar substantial savings. And — completely automatic operation is afforded by the Westinghouse system of control.

This installation indicates the advantages that can be gained by a working partnership with Westinghouse, in electrification problems. For similar co-operation, address the Westinghouse District Office in your community.

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

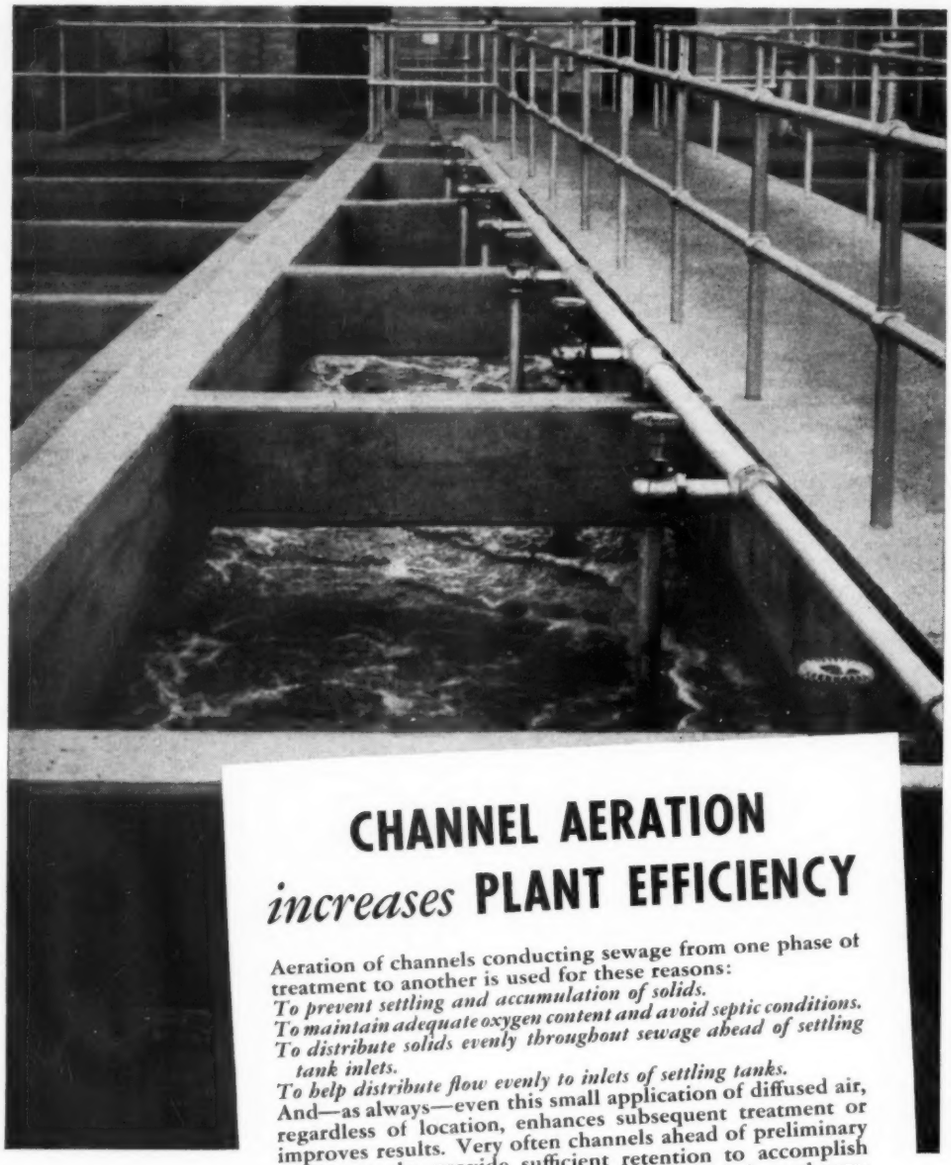
J-94148

Westinghouse

ELECTRICAL PARTNER OF THE SANITATION ENGINEER

W
WESTINGHOUSE ELECTRIC

FORCEFUL FACTS ON SEWAGE AERATION BY AIR DIFFUSION—No. 19



CHANNEL AERATION *increases* PLANT EFFICIENCY

Aeration of channels conducting sewage from one phase of treatment to another is used for these reasons:

To prevent settling and accumulation of solids.
To maintain adequate oxygen content and avoid septic conditions.
To distribute solids evenly throughout sewage ahead of settling tank inlets.
To help distribute flow evenly to inlets of settling tanks.

And—as always—even this small application of diffused air, regardless of location, enhances subsequent treatment or improves results. Very often channels ahead of preliminary settling tanks provide sufficient retention to accomplish grease separation. In short, the versatility of channel aeration increases plant efficiency at every turn.

Write to our trained sanitary engineers for further details on this or previously discussed "Forceful Facts".

To be sure you obtain every benefit of channel aeration, use Aloxite Brand Diffusers.

POROUS CARBORUNDUM PRODUCTS REG. U. S. PAT. OFF.

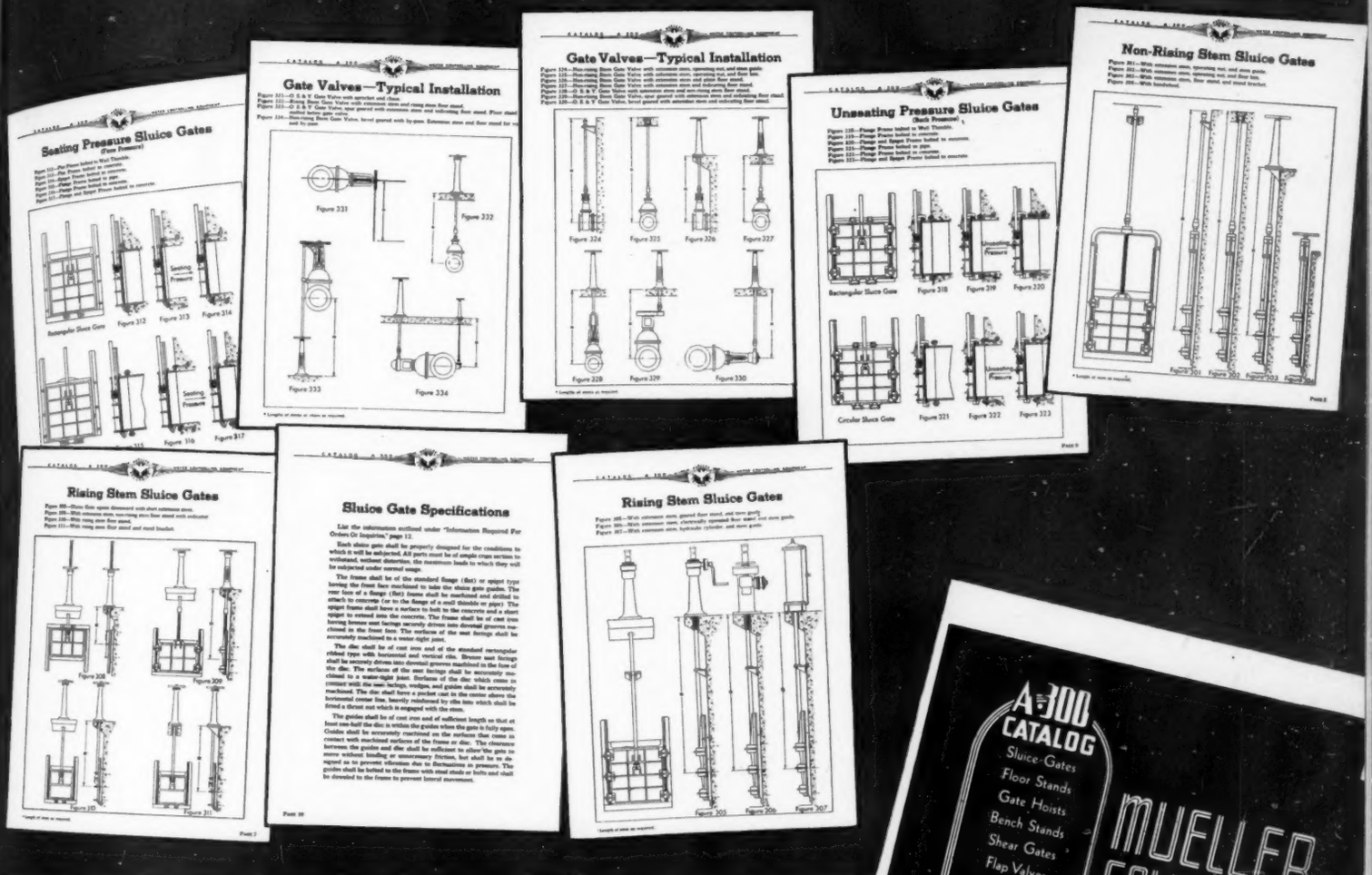
THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

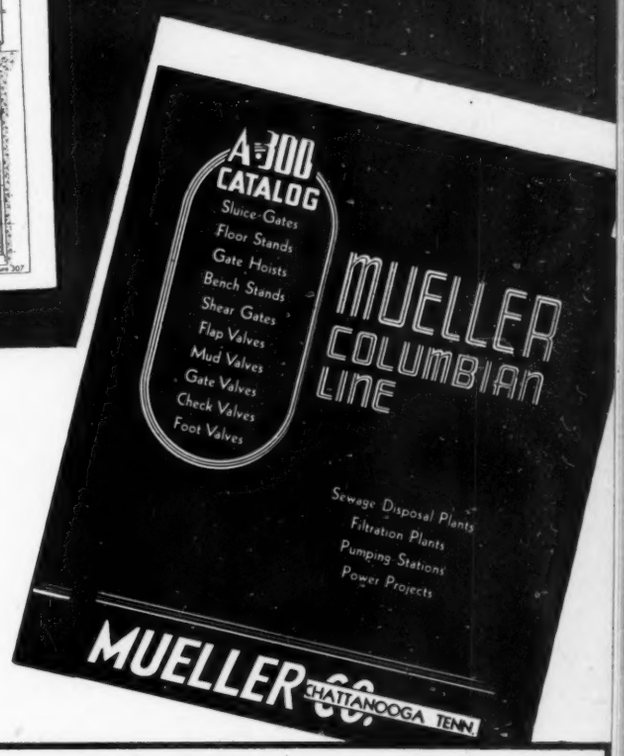
Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum and Aloxite are registered trade-marks of The Carborundum Company)

SLUICE GATE & GATE VALVE

TYPICAL INSTALLATIONS





Not only does the Mueller A-300 Catalog show the complete line of standard sewage disposal equipment, but it also shows many typical installations of Sluice Gates and Gate Valves. This information has saved many a dollar on water controlling projects because it has permitted engineers and designers to use the knowledge of Mueller engineers and to plan their projects around standard equipment, often eliminating special equipment.

This combined catalog and hand-book of information should be in the hands of everyone interested in water controlling projects. If you haven't your copy, tear off the attached coupon and mail it in today.

MUELLER CO.

CHATTANOOGA, TENN.

Mueller Co., Dept. WS 1039
Chattanooga, Tenn.

Gentlemen:

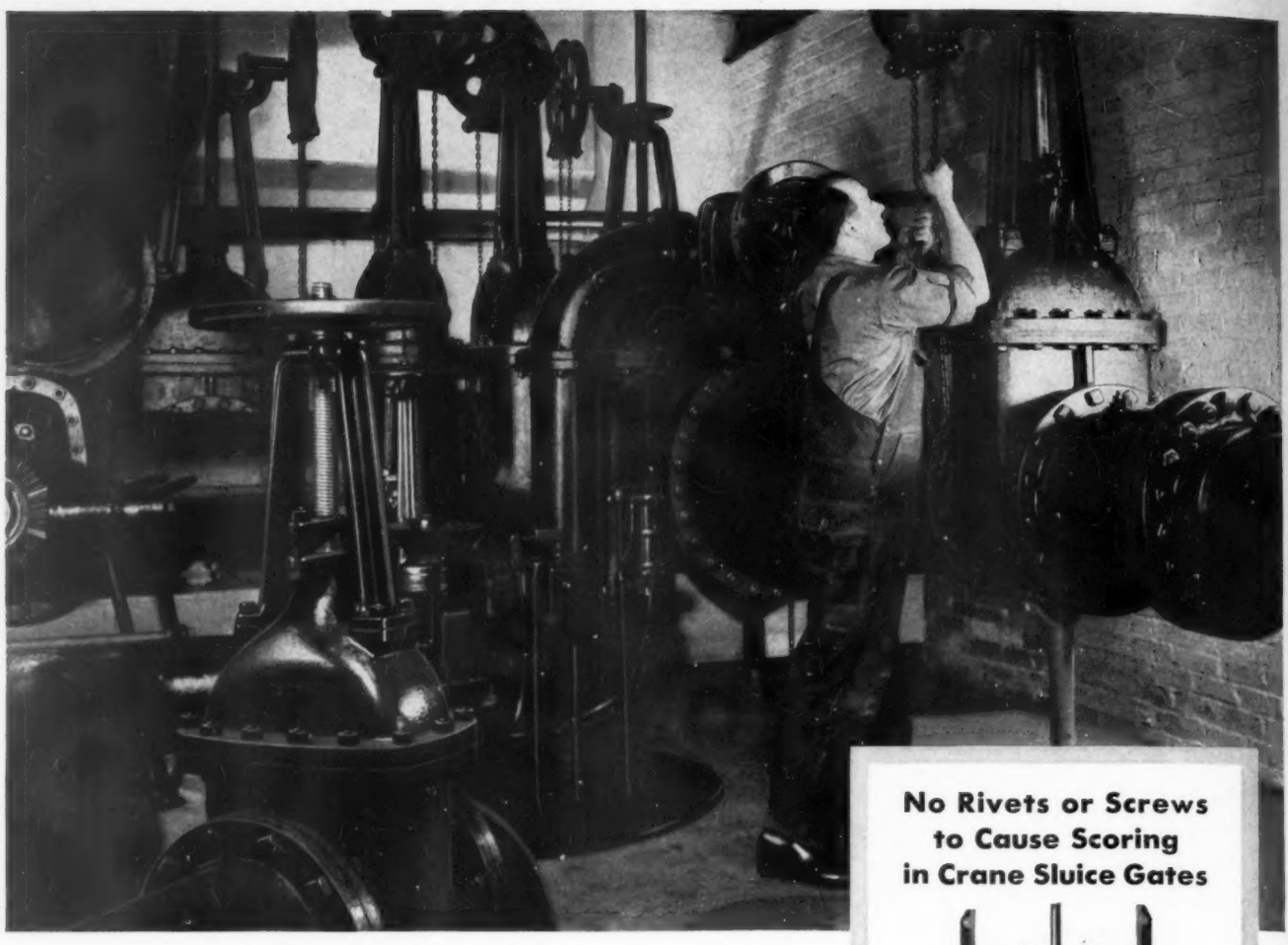
Please send me a copy of your A-300 Catalog at once.

Name _____

Position _____

Address _____

City _____



ACTION *When You Need It!* with CRANE Water Works Valves

YOUR water supply plant is a 24-hour day business—with exigent situations always threatening. And for control of most emergencies you must look to valves.

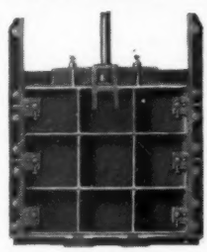
Because, as a rule, valves in water works are infrequently operated, with the disc in opened or closed position for long periods, unfailing response must be assured when it is necessary to shut off or divert flow.

And because Crane valve design gives recognition to such service, and Crane engineering provides the resistance to mechanical strains, and corrosive effects both inside and out, you can depend on Crane valves for smooth, positive action when you want it.

Consider the need of Crane-Quality valves from the standpoint of maintenance. You know the cost of valve replacements, especially on large lines, the dangers of interrupted operation. The extreme accuracy with which Crane valves are built—the careful analysis and specification of materials that go into every part—and Crane's 84-year manufacturing experience—assure enduring, economical performance.

What's more, Crane supplies the *right* equipment for every flow control service in pumping stations, filtration and sewage plants. Enjoy the advantages of one high standard of quality—one source of supply—and one responsibility for all your piping needs. Choose them from the 38,000 items in your Crane No. 52 Catalog.

No Rivets or Screws to Cause Scoring in Crane Sluice Gates



There are no rivets or screws in Crane Sluice Gate seats to work loose and interfere with smooth operation—to cause burrs that cut deeply into seating surfaces. The Crane method of seat mounting avoids this danger. Crane bronze seats are rolled into dovetail grooves of ample section machined in the face of the disc. After rolling seat facing into the grooves, seating surfaces are machined to a smooth tool finish.

That's just one of the many reasons why Crane Sluice Gates give superior service—smooth and positive through long years. Crane's vast experience and facilities in engineering water control equipment back up the dependability of every part—frame, disc, guide rails, operating mechanism—assure faithful performance. Consult your Crane Representative.

CRANE

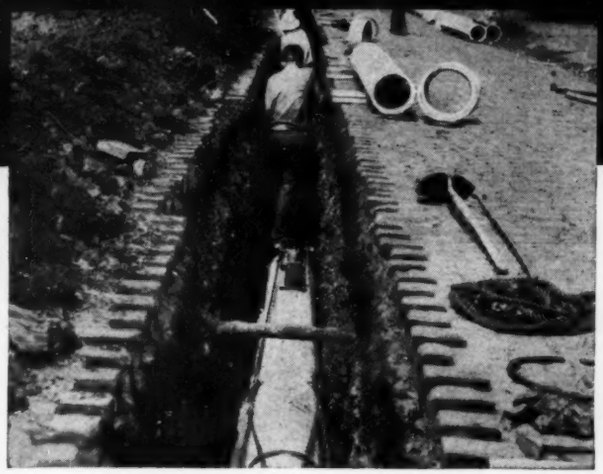
CRANE CO. GENERAL OFFICES
836 S. MICHIGAN AVE., CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

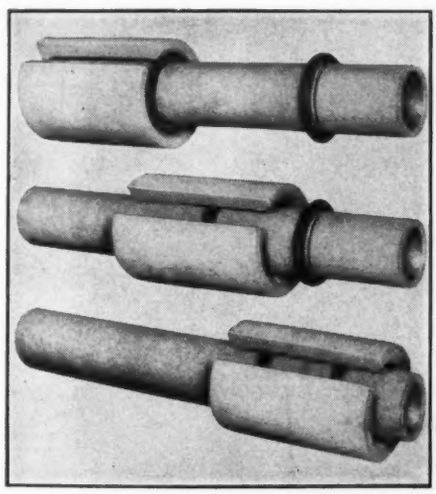
3rd FEATURE OF AN EFFICIENT, LOW-COST WATER SYSTEM

FLEXIBLE JOINTS THAT STAY TIGHT



RAPID INSTALLATION can be accomplished with unskilled crews, for Simplex Couplings are easily assembled. No heating equipment is necessary on the job... the only tool required is a simple chain puller. And, because Simplex Couplings do away with the need for large bell holes at joints, trenches can be held to minimum widths.

TIGHT JOINTS formed by Simplex Couplings *stay* tight. Their flexibility permits laying straight lengths of Transite around wide sweeps, saving field bends and special fittings. Because leakage is held to the minimum, costly water loss is eliminated and pumping costs are kept low.



HERE'S WHY joints formed with Simplex Couplings are unusually flexible, yet remain tight. A Transite sleeve and two rubber rings are easily slipped over the end of the pipe (top). The final position, with sleeve centered over joint and the two rubber rings tightly compressed between pipe and sleeve, is shown in the bottom view.

Easily assembled, Simplex Couplings reduce installation and maintenance expense... help keep pressure high, pumping costs low

EVEN unskilled crews can lay Transite Pipe as fast as the trench is opened. The reason is the Simplex Coupling. A simple chain puller is the only tool required for rapid, accurate assembly. Caulking is unnecessary; no large bell holes are needed.

In the ground, savings continue throughout the system's long life. Leakage is never a serious problem, for Simplex Couplings stay tight. They help prevent breaks in mains caused by water washing away supporting soil. Costly joint leakage is eliminated and pumping costs remain low.

The coupling, of course, isn't the whole story of J-M Transite Pipe. Made of asbestos and cement, Transite is unusually corrosion-resistant, immune to electrolysis. Maintenance is negligible. And Transite's initial high flow coefficient (C-140) cannot be reduced by tuberculation. Delivery capacity stays high as long as the line is used.

More than ten miles of J-M Transite Pipe are giving exceptionally efficient, low-cost service at the New York World's Fair. For details on the 25-year service record of this modern water carrier, send for Transite Water Pipe brochure TR-11A. And, if you are interested in reducing the expense of sewage disposal, write for Transite Sewer Pipe brochure TR-21A. Johns-Manville, 22 East 40th St., New York, N. Y.

Johns-Manville TRANSITE PIPE AN ASBESTOS PRODUCT

THE MODERN MATERIAL FOR WATER AND SEWER LINES

Liquid Chlorine ★ Perchloron

★ ★ ★

Two notable products now work together to help you safeguard the water supply of your community. One is liquid chlorine so pure that it materially reduces operating difficulties. The second is Perchloron, which acts as a second line of defense in time of emergency. Both together give you a *System of Safety* that is almost unfailing.

The liquid chlorine supplied by this Company is a great advance in purity, for it is virtually free from organic impurities. This is made possible by a new purifying process developed by Pennsylvania Salt which reduces trouble-making substances to so low a point that even their cumulative effect over long periods of operation can scarcely be traced.

As a further safeguard, a new means of manufacturing control was developed—an improved analytical method of evaluating chlorine as to troublesome impurities. Every available means has been used to provide you with a product that minimizes the formation of "taffy". You are certain to find this a superior liquid chlorine.

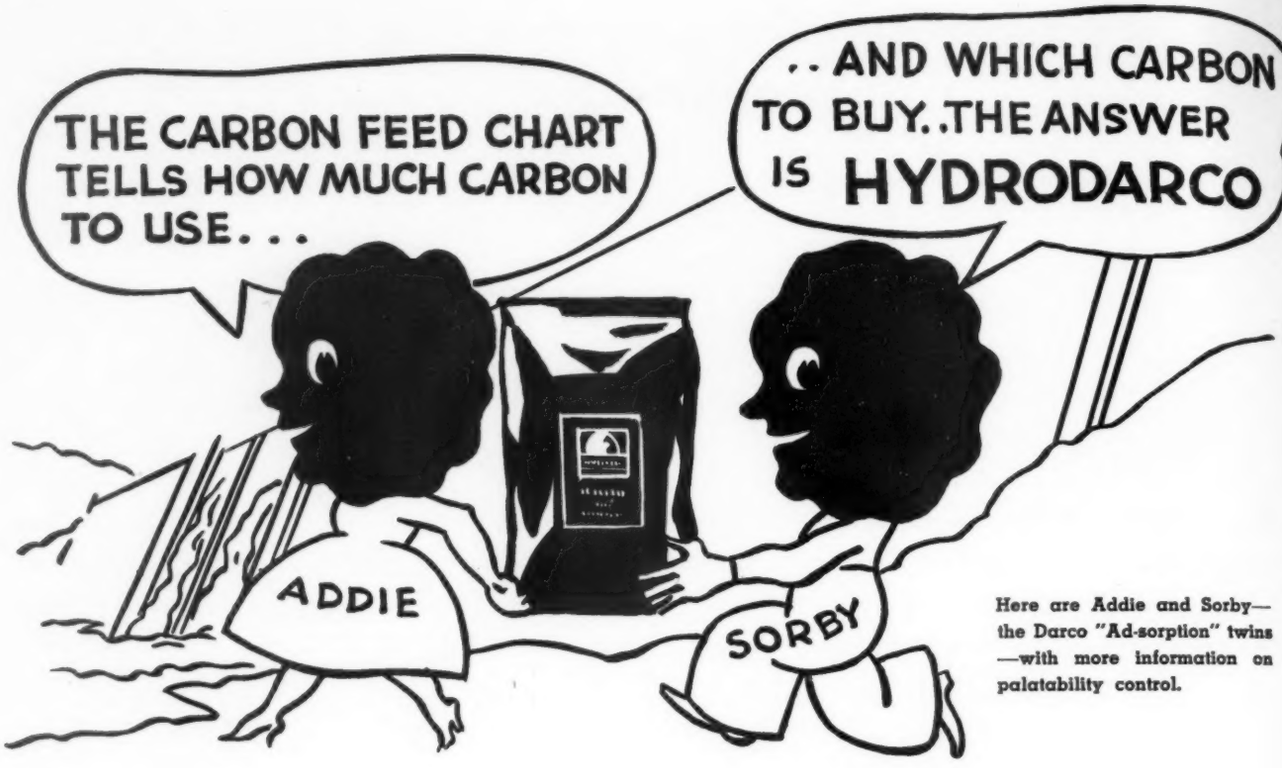
If ever your chlorine supply fails . . .

If normal conditions were the only ones possible, you would never need to prepare for emergencies. But a hurricane, a blizzard, a flood, or a tremendous fire, may tie up transportation and deprive you of normal supplies of liquid chlorine. That is when you will appreciate Perchloron.

With an available chlorine content of over 70%, Perchloron is a dependable source of chlorine in emergency. It is stable, concentrated, uniform. Dissolves readily in water. Packed 12 handy cans to the case, each can with punch-and-pry-up top. Also in 75 lb. drums.

It is convenient and economical, not only for emergency chlorination, but for sterilizing new mains, for clear wells and filters, and for swimming pool sanitation. Write for free booklet today. Pennsylvania Salt Manufacturing Co., Widener Bldg., Philadelphia, Pa.—New York • Chicago • St. Louis • Pittsburgh • Tacoma • Wyandotte.

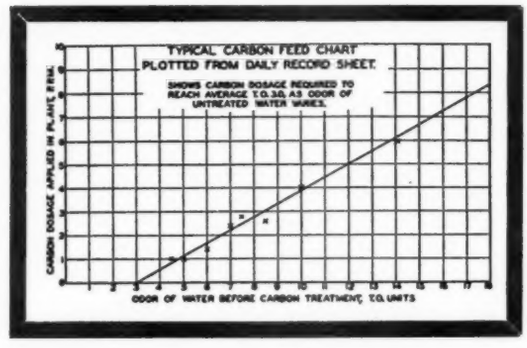
PENNSYLVANIA SALT
MANUFACTURING COMPANY
Chemicals



Here are Addie and Sorby—the Darco "Ad-sorption" twins—with more information on palatability control.

Odor conditions vary widely in any water works plant. At times they require higher carbon dosage than ordinarily thought necessary. That's why it pays to use the right quantity of the most efficient carbon—and to check closely into prices.

The Carbon Feed Chart provides accurate information to guide water works men in choosing and using activated carbon. Start a Carbon Feed Chart now! It will prove that you can count on HYDRODARCO* not only for best palatability control per dollar—but also for the *uniform* high activity to help regulate varying odor conditions.


TYPICAL CARBON FEED CHART
PLOTTED FROM DAILY RECORD SHEET
SHOWS CARBON DOSAGE REQUIRED TO REACH AVERAGE T.O. 3.0, A3 ODOR OF UNTREATED WATER MARKS.
CARBON DOSAGE APPLIED IN PLANT, P.P.M.
ODOR OF WATER BEFORE CARBON TREATMENT, T.O. UNITS

The Carbon Feed Chart is practical and easy to use. It requires no special equipment. Use this chart—and use HYDRODARCO, the activated carbon specially made for water treatment.

*Reg. U. S. Pat. Off.

DARCO

DARCO CORPORATION

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WATER WORKS & SEWERAGE

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E. S. Gillette, Publisher

EDITORIAL OFFICE
155 East 44th Street New York, N. Y.
L. H. Enslow, Editor

COMING!

Articles

"Centrifugal Pump Testing"
Is a discussion of the things that most commonly cause low efficiency and high cost of pumping. Second, things to consider in the selection of a centrifugal pump for the job. Third, a presentation of a simplified and practical method of routine checking of centrifugal pumps for efficiency.

(Mr. Beckwith's article, of high practical value, has long been scheduled to run in this issue. With regrets, however, we find it necessary to hold it for our November issue.—Ed.)

"Sewer Maintenance" constitutes a recital of experiences in maintaining the sewers of Rockville Center, L. I.—plus a description of methods developed, equipment found most practical to employ for various purposes, development of a systematic inspection and cleaning program, record keeping and costs. The author, with a background of experience in industrial plant management, has done a splendid job of systematizing sewage works operation and sewer maintenance.

"America's Filtration Plant of Tomorrow"
To our thinking such is Milwaukee's new plant now in operation. Its many novel features will be covered, several in detail, together with early operating experiences recounted by the man who fought many a battle before the new plant was a realization.

"A Filter Dressing Rig" is a description of a highly useful and time and labor saving rig for the removal of wire and cloth from vacuum sludge filters and their replacement. Its use materially simplifies the troublesome re-clothing operation. This useful rig was designed and constructed at the new sewage treatment works of Columbus, Ohio. Following the Van Kleeck series of articles on "Sludge Filtration" which are completed with this issue, the description of the "Filter Dressing Rig" is timely.

Interpretation of Results of Chemical Analysis of Water" is a paper, the context of which is essentially told in its title. In addition to a discussion of the results from the so-called sanitary analysis, alkalinity and hardness, the paper illustrates the procedure followed in quantitatively combining the positive and negative radicals derived from a mineral analysis.

Authors

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Rockville Center, L. I., N. Y.

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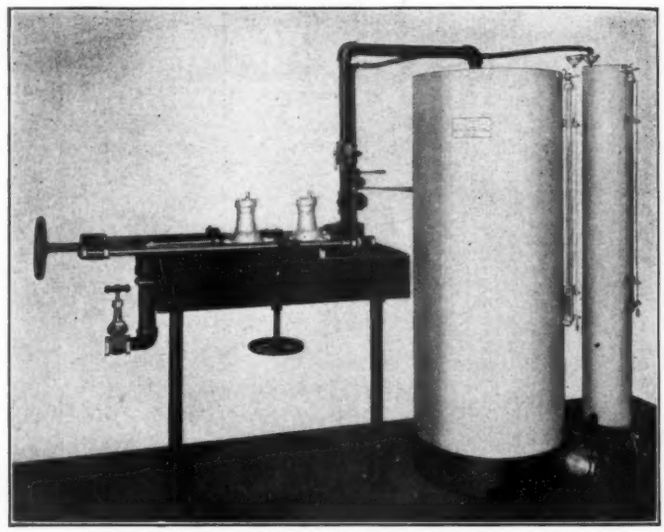

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WATER WORKS & SEWERAGE

VOL. 86, NO. 10 *A Gillette Publication* OCTOBER, 1939

SUBMERGED COMBUSTION

Recarbonation of Lime Softened Water

By

L. H. SCOTT[1] Oklahoma City

and

F. C. ABBOTT[2] Tulsa, Oklahoma

CHEMICAL reactions taking place in water softening by use of lime do not go rapidly to completion. As a result of this reaction lag, lime softened water is usually supersaturated with respect to calcium carbonate. Such water is incrustant, since it tends to reach equilibrium after passing through the softening plant by precipitating that amount of calcium carbonate constituting super-saturation. Precipitation may occur at any subsequent point in the distribution system, but normally occurs most seriously on sand filters, in water mains, and in hot water heaters and lines. It becomes a serious problem not because of precipitation only but because the deposition occurs on surfaces as a hard scale. This property seriously impairs efficiencies of sand filters, and of the pumping plant by causing increasing friction loss through the mains.

To prevent deposition of calcium carbonate scale it has become customary to stabilize lime softened water. This may be done by one of several methods such as: recarbonation which causes conversion of relatively insoluble calcium carbonate to the soluble bicarbonate salt; recirculation of the water through a calcium carbonate sludge thus providing enormous surfaces on which deposition of that portion of calcium carbonate constituting supersaturation may be deposited; and by addition of small quantities of soluble chemicals whose presence prevents or retards deposition of calcium carbonate.

Recarbonation an Established Method

Of these methods recarbonation is probably best known and most widely used. As a process it possesses many advantages that are well known while disadvantages attributed to recarbonation are, when analyzed, found mainly to be disadvantages of equipment commonly used to effect the process. Standard equipment for recarbonation is massive, costly to install and maintain, subject to severe corrosion, and difficult to control. The usual practice is to burn coke or fuel oil to produce carbon dioxide. The gases from the producer must be filtered, washed, dried, and finally compressed for passage through a submerged grid or gas diffusion apparatus into the water.

Some Aspects of Submerged Combustion

It may be recognized by many operators that submerged combustion of a fuel free from sulphur compounds offers possibilities of greatly simplifying recarbonation practice. It makes possible the use of automatic controls and the cause and effect of corrosion is removed by eliminating the need for scrubbing and compression of the acidic dioxide bearing gases. Also the expected increase in overall chemical efficiency (ratio of carbon dioxide utilized to that available from complete combustion of the fuel), with a corresponding decrease in fuel costs, may be recognized as a probable effect to be gained by submerged combustion. Apparently, however, no such apparatus has ever been installed and operated in municipal water softening plants as an integral part of the full scale plant. This is probably because submerged combustion has until recently been an interesting theoretical possibility instead of a dependable piece of practical equipment.

With development of a commercially dependable system of submerged combustion and its continued satisfactory use as an efficient method for effecting evaporation of a corrosive and badly scaling chemical solution, the opportunity became available to test its effect in recarbonation. The Water Softening Plant of Oklahoma City presented a splendid opportunity for such tests since no other method for stabilization was in use at this plant and hence the full effect of submerged combustion in recarbonation could be measured. The Oklahoma City plant is normally operated at rates varying from a minimum of 8 M.G.D. to a maximum of 22 M.G.D. Although a flume was provided for the purpose in the design and construction of the plant, recarbonation has not been practiced for several years.

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This flume is about twelve feet wide, seventy feet long, and fourteen feet deep at the lowest point. The depth of water maintained varies between eight and ten feet. Water flows by gravity from the flume into a pit about twelve feet square by sixteen feet deep and from there into a four-foot diameter buried concrete line leading to the filters. This line leaves the pit at an angle of about 90° to the direction of water flow in the flume. Recarbonation testing by use of submerged combustion equipment was done at various times in this 12-ft. square pit, and thereafter with the burner directed into the four-foot influent line in a way such that the burned gases traveled with the water to the filters where those unabsorbed were released to atmosphere. Other trials were made in the recarbonation flume just ahead of the pit above referred to. Most of these tests were made between August 1st and November 15th, 1938, although a few preliminary trials were completed in April, 1938.

Equipment and Procedure Employed

On all of the test work a manually controlled experimental submerged burner, taken from the semi-commercial laboratories of the developer, was used. This unit was considerably under capacity with respect to the maximum flow through the plant but served very well on the medium and low flows. In spite of its undercapacity, however, a good fraction of the work was done during periods of near maximum water treatment, resulting in records showing the chemical efficiency of the unit, even when total reduction in alkalinity of the water was not accomplished.

Figure 1 diagramatically illustrates the arrangement and kind of equipment used during the experimental work. Sources of supply of air and fuel (in these tests natural gas) at pressures great enough to overcome line friction and back pressure resulting from the head of water representing burner submergence had to be provided. Normally, pressures ranging from 7 to 10 lbs. per sq. in. are sufficient. In the work at Oklahoma City, air was provided at different times by a low pressure rotary compressor and by a higher pressure positive displacement compressor. Gas at sufficiently high pressure was available from the mains. Both the air and gas supplies are passed through pressure regulators to level out any variations and to thus supply to the subsequent mixing equipment gas and air at constant pressures. [This becomes more important in using the manually controlled mixing chamber such as was used in these tests than it is in use of an automatic gas-air proportioner, since variation in the flow of either gas or air due to pressure change cannot be readily compensated with the experimental unit.] Also in operation of the experimental unit both the air and gas consumed were metered to enable check and control of proper proportions for complete combustion.

Gas-Air Mixer

The gas-air mixer used in the test work consisted simply of valved air and gas lines leading tangentially

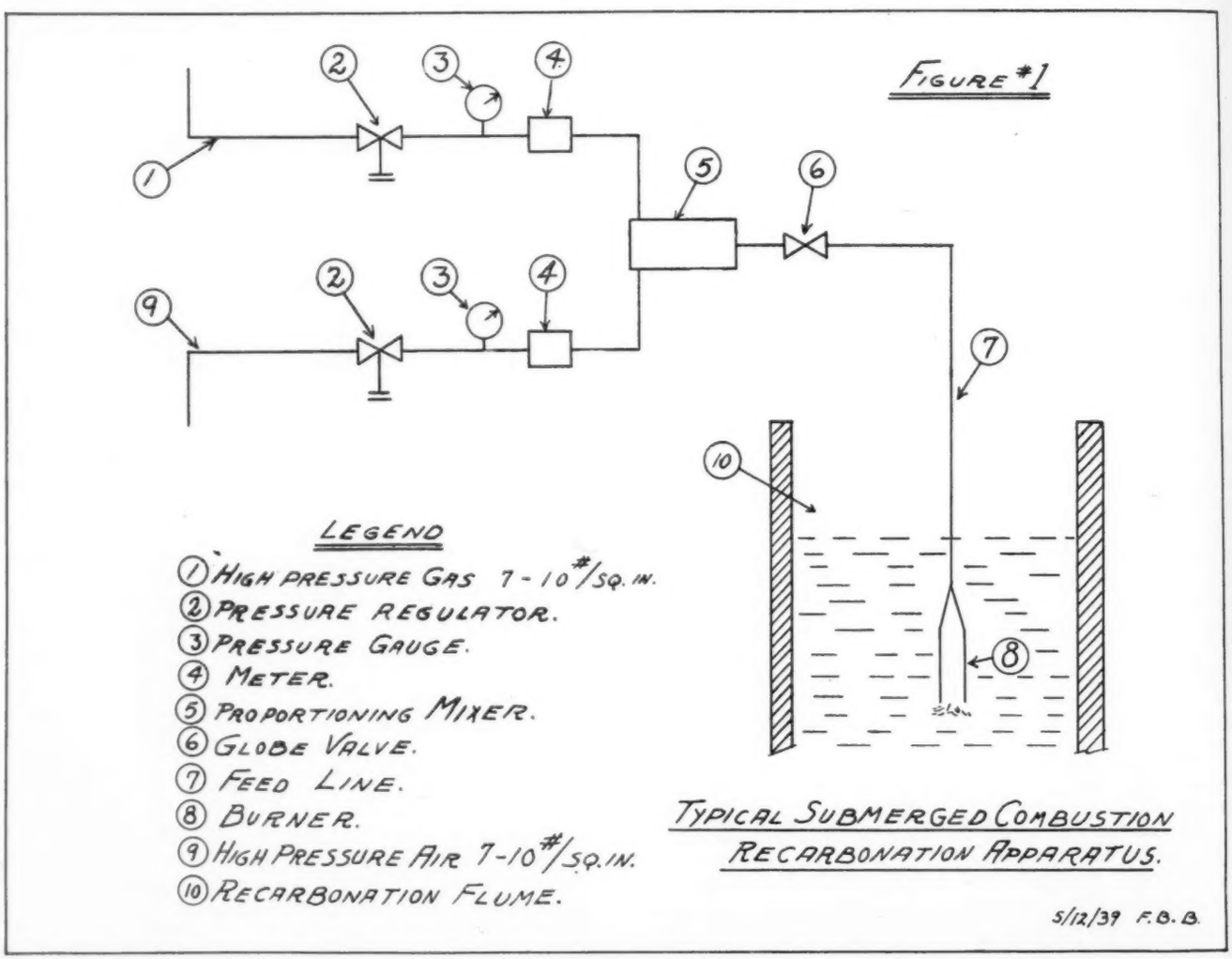


Fig. 1—Diagram of Arrangement for Recarbonation bySubmerged Combustion With Under-Water Burners

into a cylinder about ten inches in diameter and twelve inches long, closed at one end of its cross-section and equipped with a suitable threaded outlet at the other end. Gas and air entering this cylinder were given a swirling motion, thus causing great turbulence and hence thorough mixing in the cylinder. The resulting combustible mixture was carried from the mixer through a flexible line to a burner shaft of suitable size attached to the submerged burner which was located at a depth of from 7 to 9 feet below the water surface. Combustion and discharge of the burned gases into the water occurred at this point.

The Under-Water Burner

The most interesting and by far the most important piece of this equipment is the burner. The design of the burner closely followed that of other burners used for evaporation of corrosive, incrusting solutions. Their use has been standard commercial practice in one of the developer's heavy chemical manufacturing plants for several years. Unlike most submerged burners described in the literature, this type does not depend on an incandescent surface for support of combustion. It consists simply of a cylindrical section of suitable diameter, open across its entire section at the bottom or discharge end, and equipped with a frusto-conical expansion chamber at the upper end. This expansion chamber is, perhaps, the most important single feature of the burner because its angle of taper largely controls both the attainable *variation* in fuel capacity and the permanence of the flame in the burner shell or cylindrical section. The capacity of this type of burner, over wide ranges of operable variation, is determined by the cross sectional area of the cylindrical section and by its length. The frusto-conical expansion chamber is normally threaded at a point near the cone apex to allow union with the mixed gas feed line. The conical expansion chamber serves the other important purpose of causing decrease in velocity of the combustible mixture at a rate of velocity decrease such that danger of flame backfire upward through the feed line to the gas-air mixer is overcome. Burners not so constructed may prove to be dangerous in this respect if, in fact, the operator succeeds in maintaining combustion during submergence.

Methods Tried

First efforts of recarbonation by use of submerged combustion were made in the pit connecting the recarbonation flume with the filter influent line. The burner was operated at a submergence of about six feet and no effort was made to increase the time of contact of the burned gases with the water by use of baffles or grids. The fuel required for complete recarbonation of lime softened water is relatively so small, when compared to the weight of water being treated, that transfer of all its heat of combustion to the water will cause a temperature change of only about ¼ to ½° F. Combustion in the submerged burner takes place at temperatures closely approaching theoretical maximum flame temperature for the fuel in question. Hence, there is an enormous energy change at the point where the burned gases issue from the burner into the water. This change serves to divide the burned gases into countless increments of bubbles, whose resultant total surface should be, and probably is, ideal for maximum carbon dioxide absorption. However, with an open mouth burner the zone of influence of these gases is relatively small. For this reason the first tests in which the burner was operated in the pit did not result in attractive chemical efficiencies. The size of the pit relative to the area covered by the burned gases allowed by-passing of a large volume of water and overcarbonation of a relatively small volume. Subsequent mixing of these two portions of water in flowing to the filter allowed measure of total reduction in phenolphthalein alkalinity and hence calculation of overall chemical efficiency.

In this plant, as in most plants, restriction of the water flow through a very narrow channel, thus to force its passage through the zone of influence of a submerged burner, proved impractical. An approach was made to this condition, however, by attaching the burner to a 45° ell connection on the feed line, allowing it to be directed into the four-foot diameter line leading to the filters. By this method the burned gases diffused through a greater portion of water and traveled with it, probably at the top of the line, to the filter building where the unabsorbed gases were released. Considerably better chemical efficiencies were gained, ranging from 48.0% to 55.1%, which closely approaches results normally obtained by conventional recarbonating equipment. Typical results are shown in Table I.

TABLE I.—TYPICAL RESULTS WIH BURNER OPERATING AND DISCHARGING INTO A FOUR-FOOT DIAMETER LINE LEADING FROM SETTLING BASINS TO FILTERS

Water Flow M.G.D.	Gas Rate cu. ft./day St. Cond.	Lb. CO_2 Produced (Complete Combustion)	Alkalinity Settled Water before Recarbonation		Alkalinity Water at Filters after Recarbonation		% Overall Chemical Efficiency of Recarbonation
			Total	Phenol.	Total	Phenol.	
16	14,976	1,836	45	35	44	23	55.1%
16	14,976	1,836	47	35	42	21	55.1
16	14,976	1,836	45	35	43	23	52.7
16	14,976	1,836	45	34	43	23	48.0

Improving Contact Diffusion

Although this method of operation gave results approaching standard it was recognized to be impractical for use in many plants and was believed to be lower in chemical efficiency than could be obtained under better conditions. Since suitable restriction of the water flow through an area readily covered by the burned gases was impractical the next best move was made by increasing the zone of influence of the burned gases. This was accomplished by the use of two types of diffuser equipment. The first type (see Figure 2) was a peaked structure with closed ends, built on 12-inch legs so that it could be placed on the bottom of the recarbonation flume and would allow water to flow both under and over without restriction. The peak was placed across the width of the flume, perpendicular to the direction of water flow to distribute the burned gases across the body of water. The burner was attached in the position occupied by the nipple shown in the illustration, provision being provided, of course, for its removal and replacement without disturbing the diffuser. The slopes were drilled with 1/16-inch holes to provide distribution of burned gases after their initial exit into the flow of water under the diffuser. These small perforations are barely visible in the picture.

The second type of gas distribution system used is illustrated by Figure 3. It approaches in construction the grid system used in conventional recarbonating

Fig. 2—Metal Gas Diffuser—Slopes Perforated With 1/16th Inch Drilled Holes

units, except that porous tubes of "Aloxite" were used for diffusion instead of the usual perforated pipes. The major purpose in testing this type of diffuser was to show the feasibility of adapting the submerged burner to any existing grid system.

Resulting Efficiencies

Both types of distributor were found in extensive tests to be about equally efficient. Typical results obtained over the three and one-half months of experimental operation are shown in Table II. Chemical efficiencies ranged during these tests from 57.6% to 88.5%, with the average being 72.8%.

TABLE II.—DATA TYPICAL OF 3½ MONTHS OF EXPERIMENTAL OPERATION IN WHICH BOTH TYPES OF DIFFUSERS DESCRIBED WERE USED

Water Flow M.G.D.	Gas Cu. Ft./Day Std. Cond.	Lbs. CO_2 Produced per Day (Complete Combustion)	Phenolphthalein Alkalinity		Pounds CO_2 Absorbed/day to Effect Changes in Alkalinity	% Overall Chemical Efficiency
			Settled Water before Recarbonation	Water at Recarbonated Filters		
16	13,824	1,693	22	10	1,407	83.1
16	11,890	1,457	21	10	1,290	88.5
20	12,960	1,590	20	13	1,026	64.5
12	12,960	1,590	18	7	968	60.9
20	14,200	1,740	18	9	1,319	75.8
8	14,200	1,740	21	1	1,173	67.4
20	14,100	1,730	22	13	1,319	76.2
12	14,100	1,730	21	7	1,232	71.2
12	12,672	1,554	22	9	1,143	73.5
20	18,230	2,235	26	16	1,466	65.6
18	23,472	2,807	25	12	1,715	61.1
12	23,688	2,904	21	2	1,672	57.6
20	24,004	2,943	21	7	2,053	69.8
16	18,274	2,240	25	9	1,877	83.8
12	18,274	2,240	25	6	1,672	74.6
20	7,056	865	22	17	733	84.7
21	7,157	877	19	14	769	87.7
21	13,622	1,670	20	13	1,078	64.6

Results in this range are 10% to 20% higher in chemical efficiency than those normally obtained by the usual recarbonation units. A large part of this gain is doubtless the result of eliminating scrubbing losses. Besides this gain, however, there are several more important advantages to submerged combustion recarbonation. These will be more apparent after a brief description of the unit designed for automatic and for semi-automatic operation.

The Automatic Unit

In the automatic unit suitable sources of air and fuel at pressures ranging upward of 7 lb. per sq. in. must be provided. At those localities where natural or artificial gas is not available at prices comparable to other less desirable sulfur-bearing carbonaceous fuels such liquid petroleum distillates as propane and butane may be used without auxiliary equipment other than storage facilities. As in the experimental unit, pressure regulators are used to provide uniform flow of both air and gas. Meters are not required but are valuable auxiliaries in that they aid in constant check on efficiency of the unit. The flow of air and fuel at constant pressures leads to the fuel-air proportioner-mixer. This piece of equipment serves to automatically compensate the flow of one gas with any variation in the flow of the other to maintain proper proportions for complete combustion. The proportion or ratio of air to gas is regulated at the time of installation and need not be altered so long as the fuel remains reasonably constant in composition. The volume of fuel, and hence mixed fuel-air in the form of a correctly proportioned combustible mixture, may be varied by a one valve control over wide limits to meet variations in water flow through the plant. If a fully automatic control of the

Fig. 3—Gas Diffuser Grid of "Aloxite" Tubes

recarbonation is desired this one valve may be electrically operated from a pH recorder-controller located downstream from the recarbonator. This feature is entirely optional, however, since manual change of the fuel flow is so simply done and does not, therefore, throw any appreciable increased burden on the operator. Changes at this point may well be made manually by the operator at the time changes in the rate of lime and coagulent feed are made.

From the proportioner, the combustible mixture flows through a short horizontal line, equipped with ball joints, to the burner shaft and on to the submerged point of ignition. A rack and pinion is provided at the surface operating platform attached to the burner shaft to allow lifting it about one foot above the diffuser during burner ignition. The ball joints make for flexibility in the horizontal feed line during this operation. A short lift of the burner above the diffuser at the time of ignition is important to prevent possible collection of combustible gases in the diffuser. In case of flame failure, which may result from interruption in flow of gas or air, the control valve at the proportioner is automatically shut off by action of a solenoid valve. When this valve closes, the electric submerged ignition unit cannot be operated until the burner is lifted above the diffuser.

Advantages Noted

It is apparent that advantages of this system over the conventional method for recarbonation are many. They include controllability, simplicity of equipment, greater chemical efficiency, trouble free operation, reduced maintenance, elimination of water and filter materials for scrubbing towers, and elimination of corrosion troubles, all at unit costs equal to or less than present costs. When operating the conventional recarbonator unit as the water flow through the plant changes, corresponding changes in the recarbonation must be made in: the fuel rate; feed water flow to the boiler; speed of compressor; and water flow rate to the scrubbers. These changes can be avoided only by loss of fuel, dilution of the carbon dioxide bearing gases and hence increased grid losses with lowered overall chemical efficiency. Estimated costs for recarbonation by submerged combustion vary with location largely as a result of differences in fuel prices. The normal range is between 60 and 90 cents per million gallons of water treated. At Oklahoma City during experimental operation the unit cost, including estimates for maintenance and amortization was 72 cents per million gallons.

Conclusions.—It is believed that the adaptation of submerged combustion to water recarbonation provides a unit that entirely eliminates the many disadvantages inherent in the now conventional equipment, and should be carefully considered for both existing lime softening installations and contemplated ones. It is suited to installation and operation in existing plants without interruption of plant operation, and exhibits advantages warranting consideration in the advancing art of water softening.

Important Changes in Patent Laws

We are indebted to S. T. Powell, Chemical Engineer of Baltimore, Md., for the information which follows concerning changes made recently in the law governing and regulating U. S. patents, copyrights and trade-marks.

What follows has been taken verbatim from a report made to Mr. Powell by his attorneys, Messrs. Green and McCallister of Pittsburgh, Pa.

Public Use Period Reduced to One Year

Effective August 5, 1940, the two-year period heretofore permitted for public use of an invention within which a patent application could be filed and a valid patent obtained, has been reduced to *one* year. This does not apply to applications filed prior to August 5, 1940, nor does it affect patents resulting from such applications.

Interference Appeals Abolished

Effective October 5, 1939, interference proceedings will be determined by a Board of three Interference Examiners, appeal from which shall be to the Court of Customs and Patent Appeals or to the District Court for the District of Columbia. This means that only one decision in interference proceedings will be rendered in the Patent Office. The above does not apply to interferences pending on or before October 5, 1939.

Copying Claims from Issued Patents for Purposes of Interference

The law which permits an applicant for a patent to copy claims from an issued patent, for the purposes of interference, has been changed so that no such claim may be copied from the patent more than a year after the issuance thereof unless the substantial subject matter of the claim was asserted as a part of the applicant's invention prior to the termination of such year.

Time for Response to Official Actions

The Statute under which an applicant has six months in which to respond to an official action by the Patent Office has been amended so that in any particular case the Patent Office may reduce the time to a period of not less than a month by giving applicant written notice of the reduction. The amendment to the Statute was approved August 7th, 1939 and became effective as of date.

Renewal Applications Abolished

Approved August 9, 1939 and now in effect is a provision for abolishing renewals. In any case in which the notice of allowance was mailed by the Patent Office prior to August 9, 1939, the old practice will remain in effect. Under the new practice, if the final fee is not paid within the allotted six months period, the patent shall be withheld, but nevertheless the Commissioner may in his discretion receive the final fee if the same is paid within one year from the expiration of the six months period, provided, however, that to take advantage of this it will be necessary to file a petition accompanied by a fee of $10.00 requesting acceptance of delayed payment of the final fee.

Prints and Labels to be Handled by Copyright Office

On and after July 1st, 1940 the Register of Copyrights will have charge of all applications for registration of prints and labels, and the fee will continue to be $6.00.

ON WATCHING YOUR CASH REGISTER

An Evaluation of the Economic Limits of Meter Maintenance

Part 2

By D. R. TAYLOR
Plant Supt., Water Department
ROANOKE, VIRGINIA

In the first installment of this article which appeared in the September issue of this magazine, the author revealed findings which came from a study of rates at which water is drawn in the average Roanoke residence. The important consideration was the percent of total takings at the several specific rates. Employing this data, as the basis, he used it in testing meters for their "Weighted Average Accuracy," which becomes the most telling test as far as the financial balance sheet is concerned. In brief, as far as revenue loss is concerned.

He also outlined some of Roanoke's testing methods and record keeping and explained their grounds for routine testing of meters once every 7th year, rather than more frequently as advocated by many. From this point Mr. Taylor proceeds.—Editor.

The Author

Our Practice

It is our practice to test every meter coming in from our distribution system, whether it has been in service one day or seven years. If it passes our testing specifications, it is bronze coated and placed in stock. (It is, of course, thoroughly cleaned before it is tested.) If it fails to meet our testing requirements, it is properly reconditioned and tested again.

To test every meter on flows of 0.25, 0.5, 1, 2, 5, and 10 g.p.m. requires an hour and twenty minutes, not including the time required to record the test. Even though we test six meters at one time, we are convinced that there is no worthwhile objective to be gained by testing on all of these flows, which were employed in our study of "Weighted Average Accuracies"—see Part 1. We are also of the opinion that it is useless to test on the rate of 2 g.p.m., the so-called "high point." We feel that the 1 g.p.m. rate is too important an index to omit, and if this be true, the 2 g.p.m. rate is too near the 1 g.p.m. rate to repeat; and then rather than to worry with a special limit for the "high point," it is better to set up specifications that are adequate in every respect, consisting of such limits that will allow for the highest probable "build up" without exceeding the allowable limit, and without a total over registration. Furthermore, the "high point" varies not only with meters of the same make but also with meters of different makes. It may vary between 1½ g.p.m. and 3½ g.p.m., and therefore it is not good practice to select a test rate for ⅝-inch meters between these two limits.

We then prepared testing specifications for used meters as shown on the chart (Fig. 9), which also includes specifications for ¾-inch, 1-inch, 1½-inch, and 2-inch meters.

For the ⅝-inch and ¾-inch meters the letter "R" means that the meter must run on the .25 g.p.m. rate, which you will find (Part 1) indicates an expectancy average of 71% and 91% on the 0.25 and 0.5 g.p.m. rates, respectively, if the meter tests between 98% and 100% on the 1 g.p.m. rate.

You will also note a maximum limit of 100.5% on the 1 g.p.m. rate in the case of the ⅝-inch meters. This point being on the ascendancy of the curve of average accuracy near the "high point," (see Fig. 10) we found that we could allow this maximum limit without any meter "building up" over 102% on the "high point." We also found that if we set the maximum limit at 100% for this rate, we experienced some difficulty in staying near 100% registration at the higher rates of flow.

These specifications, as you will note, are for *used meters only.* In the case of *new meters* we follow the A.W.W.A. specifications, except that our maximum allowable percentage of registration is 100.0% on all flows. We found that to allow a maximum limit above this would occasionally permit a new meter in the soft water (film forming) section of our system to "build up" slightly over 102% on the "high

FIG. 9—METER TEST SPECIFICATION CHART

— For Used Meters Only —

[The Figures are Minimum and Maximum % Registration Tolerances.]
R indicates meter must run at rates shown.

G.P.M.	.25	.5	.75	1	1.5	2	3	4	5	10	15	20	30	40	80	85
⅝"	R			98 100.5					98 100	98 100						
¾"	R			98 100					98 100		98 100					
1"			90 100	98 100			98 100			98 100			98 100			
1½"					90 100	98 100				98 100			98 100		98 100	
2"						90 100	98 100		98 100			98 100		98 100		98 100

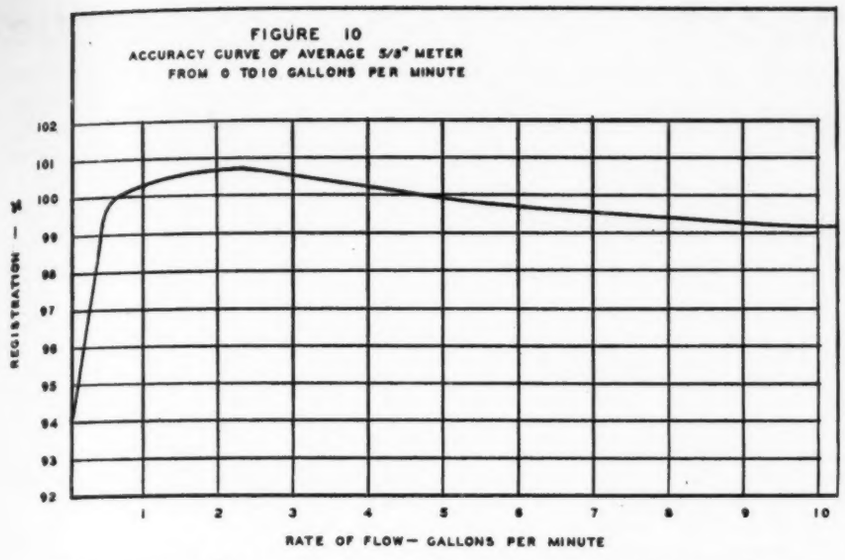


Fig. 10—Curve of Average Accuracies for 5/8" Meters at Various Rates

We might say here that in obtaining these weighted average accuracies we did not include any meters that had stopped entirely, because by so doing we would not have obtained true results. In each hundred meters removed for these special tests, there might be found several which had entirely stopped, but these stopped meters should not be included in such averages, because these meters would have been automatically removed immediately following the reading date as a result of orders from the meter reader or billing department, and therefore they would not have remained in service for the entire period for which data is required in completing such a study.

Those having ceased to register on the two lowest rates should be included, however, because in this case the drop in registration in all probability would not be sufficient to cause a removal order to be made, and it is just this type of undetected gradual decrease in total registration that we are attempting to devise some method of economical solution.

The stopped meter is a simple problem; it leaves us with only one alternative. But the meter that gradually decreases in total registration, at a rate we will say of three cents per month, is the real problem child. How can we determine what the rate of this decrease actually is? If we can determine this rate, then how can we establish the most economic interim of time or length of service for this meter before it should be reconditioned? Let us pursue our study a bit further.

point," and we would prefer losing what is really a negligible amount in other sections than to have a single meter in our system exceed the allowable limits, because just as one rotten apple can spoil the whole barrel, one unjust act, though it may be unintentional, may go far toward hurting your public relations.* You will also note that the "high points" have been avoided in all cases as previously explained.

The Testerate Indicator (pictured in Part 1) is used for all rates up to and including 30 g.p.m. For all rates above 30 g.p.m. we use calibrated orifices, and in the case of these high rates, a varying flow of a few gallons per minute makes no practical difference in the results.

In Table 11 you will observe the mental picture presented by the weighted average accuracy chart of meters satisfying our testing specifications for used meters—Fig. 9.

To add a little more to the picture, Table 12 shows the estimated loss by meters that measure up to our testing specifications.

Such a computation could be made for any particular year, as for instance seven years, as shown in Table 13.

We have shown you the weighted average accuracies of our average used meter after one year of service and after seven years of service (Tables 7 and 8 respectively). We then constructed a curve setting out these facts, which is shown in Fig. 14.

The solid line represents results obtained under a routine maintenance plan, and the dotted line those obtained without a routine maintenance plan.

TABLE 12—ESTIMATED LOSS FROM AVERAGE USED 5/8 INCH

[Computed for the Average Meter Passing Test Specifications for Used Meters]

G.P.M.	Per Cent Used	Gallons Used	Per Cent Registered	Per Cent Lost	Gallons Lost
.25	5	150	71.0	29.0	43.50
.5	6	180	91.0	9.0	16.20
1.0	8	240	99.0	1.0	2.40
2.0	31	930	100.3	+ 0.3	+ 2.97
5.0	40	1200	99.5	0.5	6.00
10.0	10	300	99.0	1.0	3.00
		3000*			68.13**

* Observed average monthly use by domestic consumers in Roanoke.

** At 30c per thousand: 68 gallons per month is a loss of $0.0204 per month; or $0.2448 per year.

TABLE II—WEIGHTED AVERAGE ACCURACY

[Average 5/8 Inch Meter of Various Ages, Passing Our Test Specifications]

Rate—G.P.M.*	% Used	% Registered	Computation
.25	5	71.0	.05 × 71.0 = 3.550
.5	6	91.0	.06 × 91.0 = 5.460
1.0	8	99.0	.08 × 99.0 = 7.920
2.0	31	100.3	.31 × 100.3 = 31.093
5.0	40	99.5	.40 × 99.5 = 39.800
10.0	10	99.0	.10 × 99.0 = 9.900
(*From Table 2—Part 1)			Total % Registered = 97.723

*We should explain to the readers that the Roanoke Water Department was until very recently a company owned and operated property, which the author has long served.—Ed.

Weighted Accuracies From 1 Year to 10

We wished next to obtain the weighted average accuracies for each year from 1 to 10. In the first place

TABLE 13—ESTIMATED LOSS FROM AVERAGE USED ⅝ INCH
[Meter After 7 Years of Service]

G.P.M.	Per Cent Used	Gallons Used	Per Cent Registered	Per Cent Lost	Gallons Lost
.25	5	150	45.6	54.4	81.60
.5	6	180	76.1	23.9	43.02
1.0	8	240	92.8	7.2	17.28
2.0	31	930	99.9	.1	.93
5.0	40	1200	99.1	.9	10.80
10.0	10	300	99.0	1.0	3.00
		3000			156.73**

** At 30c per thousand: 157 gallons per month is a loss of $0.047 per month; or $0.564 per year. (See Table 15.)

we did not have any meters in the system that had been in continuous service longer than seven years. In the second place, if such had been the case, the job of conducting tests to determine these figures would have been long and costly; therefore, we selected another plan which is sufficiently accurate for the purpose and is quickly executed.

We subtracted the weighted average accuracy for seven years from that for one year and divided the result by six. We then subtracted this amount (0.424) from the weighted average accuracy for one year to obtain the weighted average accuracy for two years. By subtracting the same amount (0.424) successively from the figure for each preceding year, the weighted average accuracy was obtained for the succeeding year. We computed these figures for ten years. The figures obtained, of course, agreed with the curve (Fig. 14).

Economic Limit of Maintenance Determined

Now that we have established a number of facts, figures, and axioms, let us assemble them for further deductions. Please refer to Chart 15, showing the economic limit of meter maintenance for average *used* ⅝-inch meters, repaired to meet our specifications.

The first line shows the number of years the meter in question has been in continuous service without maintenance. The second line shows the weighted average accuracies according to length of service. The third line shows the gallons not registered per month. This is obtained by subtracting the weighted average accuracy for the year in question from one hundred. The figure thus obtained is likewise the percent of the total that the meter fails to register at 100% accuracy. In other words, this is the percentage of water passing through the meter per month that is not registered. Multiplying this figure by the average monthly consumption of each domestic meter (in our case 3,000 gallons), gives the gallons not registered per month per meter.

Multiplying gallons not registered per month by your billing rate per 1,000 gallons, using the first step in your rates, gives the monetary loss per month. These figures appear in line 4. Then multiplying by twelve reveals the average loss per meter for the year in question (see line 5).

Then the total loss for the period (line 6), is obtained as follows:

The loss per year for the first year is added to the loss per year for the second year, which gives you the loss for the period of two years. To obtain the loss for three years add the loss for the third year to the total loss for the first and second years. The loss for each succeeding period (4, 5,6 or more years) is obtained by continuing the procedure of adding the figures in the several columns.

Our average cost of meter repairs according to length of service is as shown in line 7. In line 8 is shown the *net loss* for the period. This is obtained by subtracting the *average cost of* meter repairs from the *total loss* for the period. In line 9 is shown the average net loss per year per meter. Such is obtained by dividing the net loss for the period, as (line 8), by the number of years in the period in question.

All of the figures and facts shown in Chart 15 are based solely on our own experience in our plant. These figures will vary slightly in every different locality and must be obtained by actual experiments, tests, experience, and observations made by you, all of which will be governed by your local conditions.

Developing and Applying the "Loss Factor"

The most perfect results of meter maintenance would be achieved, of course, if you could recondition each meter in your system exactly at the end of a period during which the total loss for the period equalled exactly the cost of reconditioning the meter, but of course this is impossible. On the other hand, if the cost of repairing the meter after a given period of service is greater than the total revenue loss for the period, you will of course experience a *double loss* by removing it for repairs at that time. With these facts in mind we believe it is therefore more economical to allow the total loss for the period to become slightly greater than the cost of repairs before removing the meter for maintenance.

We have selected an amount of 12c as our factor (i. e., line of demarcation), which for the sake of convenience we will call the "loss

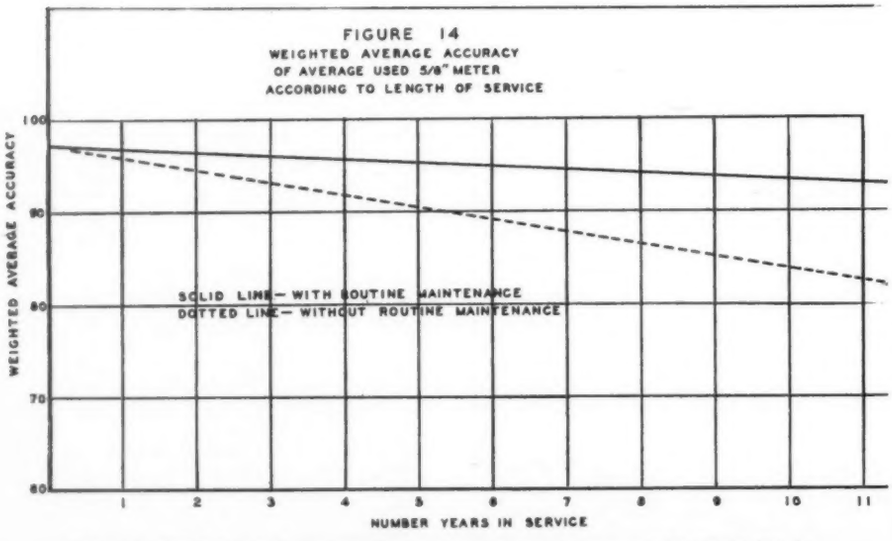


Fig. 14—Weighted Average Accuracy of the Average ⅝" Used Meter
Showing results in respect to length of service.

Chart 15

ECONOMIC LIMIT OF METER MAINTENANCE

For Average Used 5/8 Inch Meters Repaired to Meet our Specifications

1. Number of years in service	1	2	3	4	5	6	7	8	9	10
2. Weighted average accuracy	97.324	96.900	96.476	96.052	95.628	95.204	94.779	94.355	93.931	93.507
3. Gallons not registered per month	80	93	106	118	131	144	157	169	182	195
4. Loss per month @ 30c per Thousand	.024	.028	.032	.035	.039	.043	.047	.051	.055	.059
5. Average loss for the year	.288	.336	.384	.420	.468	.516	.564	.612	.660	.708
6. Total loss for the period	.288	.624	1.008	1.428	1.896	2.412	2.976	3.588	4.248	4.956
7. Average cost of meter repairs according to length of service					2.03	2.12	2.23	2.34	2.46	2.58
8. Net loss for period (loss for period less cost of meter repairs)						.292	.746	1.248	1.788	2.376
9. Average net loss per year per meter (net loss divided by years in period)						.049	.106	.156	.199	.238

factor." In other words we have decided that a net loss per year per meter of 12c (1c per month per meter) is the figure that we should be governed by in establishing the frequency of removing meters for periodic maintenance.

You will note that in our case seven years is the frequency that produces a "loss factor" closest to 12c, or in other words a net loss per year per meter of 10.6c—line 9 at 7 years.

This is, of course, a matter of personal judgment. There are several instances in which judgment, influenced by local conditions, will necessarily have to be used. With this in mind may we discuss the selection of this "loss factor" as a governing element.

You will note in Chart 15 that the "loss factor" for periodic repairs every six years is 4.9c. We feel that to attempt to operate our meter maintenance schedule on this basis might result in false economy, for the simple reason that even slight variations, irregularities, or minor upsets could easily cause us to spend more money for meter repairs than has been lost, by underregistration, during the period. On the other hand, if we attempted to follow the eight-year plan, we feel that the "loss factor" of 15.6c is too great a difference.

We realize, of course, that it is very improbable that the 12c result will be obtained exactly; however, we are positive that some definite figure should be selected as a basis from which to work.

This figure is, of course, controlled to a great extent by the many factors that we have previously enumerated. Therefore, if having determined the facts in your particular case you find that your "loss factor" is, say, less than 5c on a six-year plan and likely 23c on a seven-year plan, then by all means adhere to your six-year plan until your plant has grown or until some other change of conditions indicates that it is more economical to go to the seven-year plan. On the other hand, this method of determining the economic limit of meter maintenance may actually reveal an economy by more frequently repairing your meters than the present schedule calls for.

Under still other circumstances you may find that you should repair more frequently but to do so would require additional personnel in your meter department. The additional work might not require the services of a full-time man to secure the maximum economy, in which case it might be possible to use the additional man part time in your meter department and part time in some other department.

Still another condition might exist under which it might be found that you should lengthen the frequency of maintenance, in which event you might not need the full time of one of your present employees. In this case the remedy might also be that of finding other duties in another department that would require part of this man's time. These are all matters of judgment which will necessarily have to be decided by you, depending upon your local conditions. Three other factors that will influence the results obtained by this method are your rates for the sale of water, your rates of pay for your personnel, and your cost of meter repairs.

What Constitutes Repair Costs

While we are on the subject of meter repairs may we say that we have tried to include everything that should be included in the compilation of these costs. Table 16 reveals the items covered.

TABLE 16—AVERAGE COST OF REPAIRS OF SEVEN YEAR METERS UNDER OUR SPECIFICATIONS

Remove for repairs and replace with another meter.		
Labor	.20	
Drayage	.05	
		.25
Repairs.		
Materials	1.19	
Labor	.59	
		$1.78
		$2.03
Overhead 10%		.20
Average total cost of meter repairs including cleaning, testing, and bronzing		$2.23

We believe that the cost of removing the meter in the field and replacing it with another meter and returning the meter to be repaired to the meter shop is as much a part of the cost of reconditioning this meter as any other part of the necessary work. We also believe that the 10% added for the overhead should be included, because like the "salesman's overcoat" it is somewhere in the "swindle sheet," whether you can see it or not.

What About A.W.W.A. Specifications?

One of the questions we are asked is, "Why not follow the A.W.W.A. specifications in your meter maintenance program?" The only exception that we make in our case is on the .25 g.p.m. rate. However, let's see what results we will obtain if we did adhere strictly to the A.W.W.A. specifications. Chart 17 shows the economic limit of meter maintenance for our average used 5/8-inch meter repaired to make them comply with A.W.W.A. specifications. The figures for Chart 17 are computed in the same manner as those shown in Chart 15.

We wish to call your attention especially to the fact that under these conditions the average cost of meter repairs increases materially and that a *twelve-year* plan would have to be adopted before our "loss factor" (average net loss per year per meter) reached 12c.

We feel that as a matter of good business, efficiency, and economy it is better to give any piece of equipment frequent minor maintenance rather than infrequent major maintenance, where the results obtained are the same. We feel that this is especially true in the case of a piece of equipment as sensitive as a water meter.

We also feel that more than a ten-year period between the removal of meters for repairs is too great; that is, ten years should be the limit in any case, and if you can accomplish the same results in something less than ten years, it is better. If you can follow the A.W.W.A. specifications and yet fall within the ten-year limit, you will of course lose nothing by so doing, otherwise it is better to work out your own specifications to suit your own particular needs or conditions.

Use of Meter Shop Reports

Fig. 18 shows our form of meter shop reports submitted weekly by that department.

All tests of incoming meters are recorded on this form as being from the distribution system as shown. This is a typical sheet the weekly report which consists of several sheets. The only omission in this exhibit is the number and name of

Chart 17

ECONOMIC LIMIT OF METER MAINTENANCE

For Average Used 5/8 Inch Meters Repaired to Meet A.W.W.A. Specifications

1. Number of years in service	1	2	3	4	5	6	7	8	9	10	11	12
2. Weighted average accuracy	98.460	97.998	97.536	97.074	96.611	96.148	95.686	95.224	94.762	94.300	93.838	93.376
3. Gallons not registered per month	46	60	74	88	102	116	129	143	157	171	185	199
4. Loss per month @ 30c per M	.0138	.0180	.0222	.0264	.0306	.0348	.0387	.0429	.0471	.0513	.0555	.0597
5. Average loss for the year	.1656	.2160	.2664	.3168	.3672	.4176	.4644	.5148	.5652	.6156	.6660	.7164
6. Total loss for the period	.1656	.3816	.6480	.9648	1.332	1.749	2.214	2.728	3.494	4.110	4.776	5.49
7. Average cost of meter repairs according to length of service					2.88	3.02	3.17	3.33	3.50	3.67	3.85	4.03
8. Net loss for period (loss for period less cost of meter repairs)										.44	.926	1.46
9. Average net loss per year per meter. (Net loss divided by years in period)										.044	.084	.121

Figure 18

METER SHOP REPORT

METERS FROM Distribution System — Week Ending January 14 1939

Date Tested	W. O. No.	Size	Make	Meter No.	Company Number	Folio Number	M	1	2	3	5	10	20	30	Returned To	Date Prev. Installed
9	29668	5/8"			6110	37 18	R	90			99.1	98.8			Repair	6-15-32
	29670				9434	37 60	R	90			99.6	98.8			"	11-10-32
	26751				3424	22 977	R	94			101.8	100.8			"	3-29-32
	29675				3557	37 491	R	95			98.4	98			Stock	6-28-32
	26743				14133	35 391	R	99			100	100			"	11-4-38
	26824				50	18 208	R	80			102	100			Repair	10-25-32
	29671				6652	37 84	R	101			92	95.8			"	8-29-32
	29677				7224	37 633	R	96			99.5	97.5			"	5-18-32
	29680				11592	37 253	R	100			100	99			Stock	6-15-32
	29681				7687	37 259	R	98			100	99.5			"	8-26-32
	29679				3815	37 241	N.R	N.R			102	99.6			Repair	3-16-32
	26699				5799	15 507	R	87			100	100			"	1-17-38
	29673				13788	37 372	R	98			99.8	98.6			Stock	5-31-32
	29674				8066	37 459	R	99			99.2	98.6			"	9-22-32
	29664				3805	40 504	R	80			101.6	98.6			Repair	2-10-32
	26778				12268	24 767	R	96			99	98.6			"	11-2-36
	29663		Not included in average		4560	24 562	N.R	N.R			N.R	N.R			Repair	5-3-34
	26773				5616	30 819	R	98.5			100	99			Stock	12-28-35
10	26803				9811	33 112	R	99.5			99.2	98.3			"	12-27-38
	26675				3048	19 665	R	98			100	99.2			"	5-7-38
	26650				9226	52 556	N.R	N.R			98.2	98.2			Repair	4-12-34
	29663				10340	48 447	R	95			99	98.4			"	5-18-32
	26805				772	37 504	R	94			98.5	99			"	4-7-34
	26776				14065	32 153	R	94			100.6	99.2			"	3-24-38
	25908				5850	39 903	R	92			101	100			"	1-17-33
	26822				4617	32 617	R	98			100	99.4			Stock	4-14-38
					Average Percentage			94.5			99.6	98.7				

Fig. 18—Typical Weekly Meter Shop Report—Roanoke Water Dept.
(Report Covering Meter Testing)

meters, of which we have several makes.

You will note that this form is designed to accommodate all sizes of disc meters from 5/8-inch to 2-inch. Groups of each size are reported on separate sheets, and in the case of 1½-inch and 2-inch sizes the rates of flow greater than 30 g.p.m. are written in with ink.

This form can be used for many purposes. For instance tests of meters of any particular length of service such as one year, two years, seven years, etc., can all be grouped on separate sheets and a study made of each individual meter or groups of meters; and, likewise of different makes of meters. In this manner you can not only get a clear picture of the performance of your meters but you can also determine which particular make of meter gives the best service in your system. Use of these forms makes possible a splendid analysis of "who's who" in meterdom.

This report shows how long the meter has been in service and whether it meets our test specifications and is put into stock or whether it is sent to the repair department for reconditioning.

The 2 g.p.m. rate can also be used to occasionally spot-check incoming meters for "build up" on the high point.

Fig. 19 shows a typical sheet (of which there are usually several) of the weekly report of the repair department.

We assign what we call a department or company number to all of our meters when they are received from the factory, and this number is stamped in the inside of the register cover lid and also on the main casing of the meter. All records of final tests are recorded on history cards, of which there is one for each meter, and on which there is recorded all other pertinent information relating to the meter in question. These cards are filed in numerical order according to company number.

In our weekly report from the meter department there is also included a recapitulation of the results of the tests of meters collected from the distribution system, as shown in Table 20.

TABLE 20

Meters repaired (total)	22
Number O.K. for service	22
Balance for further repairs	4
Meters removed from distribution system	26
Not registering on any rate	1
Not registering on ¼ g.p.m. and under 90% on other rates	2
Not registering on ¼ g.p.m. and under 98% on other rates	0
Registering on ¼ g.p.m. and under 90% on other rates	4
Registering on ¼ g.p.m. and under 98% on other rates	9
Overregistering on any rate	0
O.K.	10
Total	26

AVERAGE REGISTRATION OF ALL METERS
(Except Those Entirely Dead)

G.P.M.	1	5	10
Per Cent	84.5	99.6	98.7

The facts shown in this form correspond with and are made up from the results shown in Figs. 18 and 19. Facts in Table 20 are taken, of course, from only the one sheet; however, the weekly report usually consists of from three to six such sheets.

Before leaving the 5/8-inch diameter meter, may we mention two other related facts. There has been some speculation regarding the open-type of oil enclosed gear train, or intermediates. In some localities the oil enclosed intermediate has a definite advantage; however, in our case the results vary only slightly and mostly on the low rates of flow. We would not remove a meter merely to replace an open type with an oil enclosed type; however, as our meters pass through our shop, if we find an open type completely worn out we replace it with an oil enclosed type.

The other matter has to do with the 'gearing up" of a slow meter. We do not attempt to correct the registration of an under-registering meter for the 2½% by changing the change gears. If the average of tests of all rates is below 95½%, the meter needs effective repairing.

(Note: In his next and concluding installment, Mr. Taylor will deal with Maintenance Practice as applied to the larger meters. Such has paid handsomely regardless of the seemingly pronounced increase in personnel required for maintaing the program as developed.—Ed.)

Figure 19
METER SHOP REPORT

METERS FROM Repair Department — Week Ending January 14 1939

Date Tested	W. O. No.	Size	Make	Meter No.	Company Number	Pole Number	M	1	2	3	5	10	20	30	Returned To	Date Previously Installed
9		5/8			8222		R	97			97	98			Stock	
					7289		R	99.6			100	99.7			"	
					7097		R	100			100	99.5			"	
					11286		R	96			93.5	98.2			Repair	
					11386		R	98			96.3	94.6			"	
					4289		R	100			100	98			Stock	
					6110		R	100.5			100	99.6			"	
					9434		R	100			100	98.4			"	
					11286		R	100.1			99.4	98.2			"	
					7518		R	98			98	98			"	
					6656		R	98.4			99.2	99.1			"	
					13487		R	100			99.4	98.5			"	
					15043		R	100			98.4	98			"	
					7031		R	100			100	98.7			"	
					9227		R	100			100	99.5			"	
					3429		R	93			99.4	99.5			Repair	
					11386		R	67			99.8	98			"	
					4960		R	99.2			99.4	98.3			Stock	
10					18561		R	99			98.8	99			"	
					4296		R	98.8			99.8	98.8			"	
					8970		R	99			100	99			"	
					3815		R	98.5			99.4	98.5			"	
					11386		R	100			99.4	98			"	
					12083		R	99.2			100	99.2			"	
					3548		R	100			100	99			"	
					9226		R	100			98.7	98			"	
					Average Percentage											

Fig. 19—Typical Weekly Meter Shop Report—Roanoke Water Dept.
(Report Covering Meter Repairs)

Major Van Vleck Joins Wm. Raisch Associates

Major Albion V. Van Vleck (C.E.) on Sept. 30th resigned as Deputy Commissioner of Housing and Buildings of the City of New York, in order to become associated with William Raisch and Associates, Consulting Engineers, 227 Fulton Street, New York City.

Mr. Raisch, well known in the field of Sanitary Engineering, resigned from an important position with Underpinning and Foundation Company, about three years ago, in order to establish the Consulting Engineering firm which he now heads.

With the coming of Major Van Vleck into the firm the services of William Raisch and Associates is broadened appreciably.

MONTREAL
Host to N. E. W. W. A.

War Responsible for Lowest Attendance in Decade

Montreal's McTavish High Level Pump Station

MORE novel than the fact that New England's Water Works Association held its 58th Annual Convention "abroad", was the fact that N.E.W.W.A. conventioneers found themselves in a country at war. Whether or not this had anything to do with the attendance, it is a fact that the registration at the Montreal Convention established a record low for any since the deep depression year 1930. The 1939 convention will long be remembered for its slump in registration from 689 in 1938 (at Boston), to a mere 394 at Montreal.

However, what the 1939 convention lacked in quantity it did not in quality. War worried Montrealers did their full share to make it an enjoyable convention, even in the face of the fact that scheduled trips to points of interest had to be cancelled or curtailed. And, a busy Mayor came down to dine with us and say, with exceedingly fine wit, some nice things about water works folks — including Montreal's own Chief Engineer Des Baillets and others connected with the Water Board, who so ably functioned as hosts.

An experience unique, and something of a thrill to many, was that of converting U. S. money into war depreciated Canadian currency at the rate of exchange of between $1.08 and $1.12 in Canadian dollars for one U. S. dollar. And, it was only on the closing day of the convention that Canada's new war tax so markedly upped the price of liquors and tobacco products.

The Convention Opens

The convention opened with the customary reports of the Secretary (Frank Gifford), the Treasurer (Abel Reynolds) and the Editor (Gordon M. Fair). These revealed a total membership now of 791 members, representing a net loss of 7 for the year; securities and cash on hand totaling $20,495, mostly the latter and in 9 different savings banks; receipts $1,200 above expenditures for the year; production of 4 issues of the Journal at a net record low cost of but 39 cents per member, and a net profit from all publishing activities of $306.77. Editor Fair emphasized the fact that such profit constituted the first ever to be realized, reflecting the favorable printing contract and enhanced income from advertising.

Then followed brief reports by the Finance and Legislative Committees by Chairmen Walter P. Schwabe and Arthur C. King.

Presidents

Geo. A. Sampson, Cons. Engr. (Retiring) Boston, Mass.

Percy A. Shaw, Supt. (Incoming) Manchester, N. H.

Roger Esty—Brackett Medalist

The single award of the year was the coveted Dexter Brackett Medal which was voted to Roger W. Esty, Supt. of Water, Danvers, Mass., for his paper—"Relining an Elevated Storage Reservoir With Gunite".

In his presentation, as Chairman of the Award Committee, T. R. Kendall introduced the medalist as a consistent worker for the association; a past-president, who continues to be a "wheel-horse" in N.E.W.W.A.; one who has contributed other valuable papers and discussions of benefit to fellow members. With a show of gratitude and modesty, Roger Esty accepted the medal, which he said he hoped would spur him on to greater service.

The President's Speech

Toward the end of the convention, (a N.E.W.W.A. custom), the retiring president, George A. Sampson presented an interesting analysis of the growth and service of the Association, which grew steadily to reach a peak membership of 1043 in 1917 and a drop since to 791 recorded today. He warned that "holding its own" over the past several years did not appear to be a healthful condition of the Association, and recommended that more effort be made and a means be devised to bring in the younger men to reduce the seemingly high average age of membership. In commenting on the worth of the Association and its Journal to members, Mr. Sampson pointed to the value of the 5 monthly meetings held between conventions with total attendance averaging 786 during the past 10 years—915 being the record established in 1938. Financially, N. E.W.W.A. had an accumulation of receipts over expenditures mounting from $4,667 in 1910 to $16,379 as of today. The highest registered convention attendance (720) had been recorded in New York City (1936) with Boston's 689 in 1938 the second best. The convention problems pointed to the probable selection of these two cities as convention places in alternate years, as the ultimate solution. To strengthen the Association Mr. Sampson revealed what a marked effect the securing of even one member by each member once in every 10 years would have. And this slogan of "Every member a new member every 10 years" he urged be adopted as a means toward "advancement of knowledge relating to water works and water supply, and the encouragement of professional and social intercourse among water works men".—*The Constitution.*

Officers Elected

The following officers were announced as elected by letter ballot:

President:
Percy A. Shaw, Supt.,
Water Department,
Manchester, N. H.

Vice-President:
Leland G. Carleton, Supt.,
Water Department
Springfield, Mass.

Secretary:
Frank J. Gifford, Engr.,
Boston, Mass.

Treasurer:
Abel Reynolds, Treasurer
N. E. Light, Water & Power Assn.,
Providence, R. I.

Directors:
Harold L. Brigham (Marlboro, Mass.)
Horace L. Clark (Sanford, Me.)
Karl R. Kennison (Boston, Mass.)

Papers and Discussions

The first paper on the technical program was that by Chas. J. Des-Baillets, Chief Engineer of Montreal's Water Board, which described the fabrication and test performance of concrete pipes of improved design, now under production in Europe but not yet available in America. Features of the new pipe are its extreme density (148 lbs. per cu. ft.) produced by exact grading and mix of mortar spun at 8,000 ft./min. perispheral velocity, and the precision winding of the reinforcing spiral to preclude uneven stress and hair cracks. The spiral, called the armature, is single for low pressure and double for high pressure pipes —showing 513 lbs./sq. in. average failure test.

In the ensuing questions and discussion, W. S. Lea, Consulting Engineer, Montreal, raised the question of why cement lined cast-iron pipe was given credit for a 100-year life and concrete pipe only 70 years in recent awarding of contracts compared on the basis of bids divided by the expectancy of the two products in years.

W. W. Brush, Editor, Water Works Engineering, stated that there was no satisfactory answer other than the relatively shorter history of concrete pipes, which left some speculation as to proper longevity rating.

Col. F. F. Longley, Vice Pres., Lock Joint Pipe Company, said that no one questions the durability and life of cast-iron pipes, which would continue to be favored for distribution. Obsolescence due to tuberculation was the problem which dictated the adoption of protective cement linings. In Europe reinforced concrete pressure pipe goes back 50 years but in America only 25 years, but with many and important improvements in the product during the decade past. The relative ratings of 100-year life for cast iron and 70 for concrete pipes had been derived by the U. S. Engineers Corps on basis of European experiences.

Montreal Hosts

C. J. Des Baillets, Chief Engr., The Water Board. His Worship, Camillien Houde, The Mayor. (For 20 years—more or less.) William S. Lea, Consulting Engineer (Canadian Member of the Program Committee).

With further study the new evaluations had given pipes of both materials an equal rating—viz., 100 years. And steel pipe had been raised from 35 to 50 years in making comparisons of costs based on life expectancy.

Medalist
Roger W. Esty
Danvers, Mass.

Treasurer
Abel Reynolds
Providence, R. I.

Colonel Longley stressed the importance of considering dependability in respect to predictable and sustained carrying capacity over a period of years, as being of as much consequence as durability of materials.

"Water Borne Outbreaks of Disease in New England" by Arthur E. Gorman, Engr. of Water Purification, Chicago, Ill.

Mr. Gorman in presenting a review and analysis of waterborne outbreaks of disease in New England communities, within the 17-year period 1920-1936, stressed the facts —(1) that New England had been noted for placing great dependence on protection of supply sources and water sheds and less dependence on purification measures; (2) that the outbreaks occurred in early spring and fall when water-shed pollution would most quickly reach the intakes; (3) that more than half of the outbreaks occurred in communities with populations between 1000 and 5000.

Pointing out that 6 of the New England outbreaks had been traced to cross-connections, Mr. Gorman stressed the fact that potential pollution hazards on distribution systems had been too much neglected and the matter of potential dangers of back flow from consumers premises was deserving of more consideration than prevalently given by water utility managers. As a matter of insurance against intestinal disturbances from mild contamination of the maintenance of residual chlorine to the consumers' taps had not been practiced as prevalently as it should be and could be without consumer complaints when properly done. He thought that water managers might with wisdom refuse to supply water to hazardous properties, out of self-protection in these days of increasing financial liability of the individual as well as the utility.

Francis H. Kingsbury, Sr. Asst. Engineer, Mass. Dept. of Health, stated that, whereas, the jurisdiction of the State adequately covered the sources of public water supplies and cross-connections with other sources of supply, it did not extend to plumbing arrangements on private premises. He knew of no State Health Department having such jurisdiction and but one Water Department—that of New Bedford, Mass., which was compelling correction of faulty piping and plumbing on consumer properties.

Warren J. Scott, Chief Engr., Conn. Dept. of Health, stated that now only 1% of Connecticut supplies were without protective treatment, regardless of assumed watershed safety. He cited a case in which the source seemed safe but an outbreak occurred following a temporary cessation of chlorination. In considering pollution peaks from sudden run-offs, Mr. Scott was of the opinion that ordinary chlorination would be found lacking, and felt that more attention should be given to the markedly increased safety factor provided through superchlorination followed by dechlorination. In this manner the minimum dosage would be sufficient to insure sufficient residual chlorine under all conditions and operators would not

longer be concerned with the possibilities of serving "chlorine cocktails" for breakfast. Looking to this means of insured chlorination, on the smaller supplies in particular, Mr. Scott stated that studies of the method are already under way in Connecticut.

GORDON M. FAIR, Professor of Sanitary Engineering, Harvard University, expressed the opinion that whereas water storage had its advantages and justifications, there was little ground for depending upon storage reservoirs for security against water epidemics. In water supply safety it had been adequately shown that the unusual is what counts the most and storage alone had not proved an adequate guarantee against such happenings.

PERCY R. SANDERS, Supt. of Water, Concord, N. H., stated, that facing the increasing demand of important property owners it was becoming constantly more difficult in New England to avoid some recreational use of reservoir areas. Indications were that concessions would have to be made, with greater dependence placed on treatment in the future.

"Standards of Water Quality" by FRANKLIN J. LAMMERS, Engineer, International Filter Co., New York City.

Mr. Lammers' paper, designed to inform water works men of what might be termed water quality specifications for various industrial applications, will serve a very useful purpose as a reference for water purveyors and others concerned with water supply for industrial use. The impurity tolerances cited by Mr. Lammers are those assembled from standards of water quality set by various industrial groups, associations, or committees, and involve 30 different qualities. For instance, feed-water for boilers operating at pressures above 250 lbs. must have not more than 0.03 p.p.m. dissolved oxygen; alumina 0.05 p.p.m. or less, silica under 5 parts; total hardness less than 8 parts—the low silica and alumina being required to prevent formation of destructive analcite scale.

For carbonated beverages—alkalinity up to 100 p.p.m.; organic matter (oxygen consumed permanganate test) under 10 p.p.m.; iron and manganese 0.2 p.p.m.; hydrogen sulphide less than 0.2 p.p.m.; total solids up to 850 p.p.m. After carbonation alone the pH value must be 3.5 or under, and with the acids added the finished product has a 2.5 pH value in which pathogenic organisms quickly succumb.

The most exacting specifications drawn apply to water for use in rayon production, the following being the upper limits—total hardness 8; turbidity and color 5; iron and manganese 0.03; copper 5; silica 15; alkalinity 50; total solids 40. And

N.E.W.W.A. Turn-out for the Wednesday

very close to such requirements are those for raw water ice manufacture. In addition there must be freedom from tastes and odors, which concentrate at the core. Other specifications covered water for brewing; tanning; pulp and paper production; condensers and cooling systems; canning; distilleries; textiles.

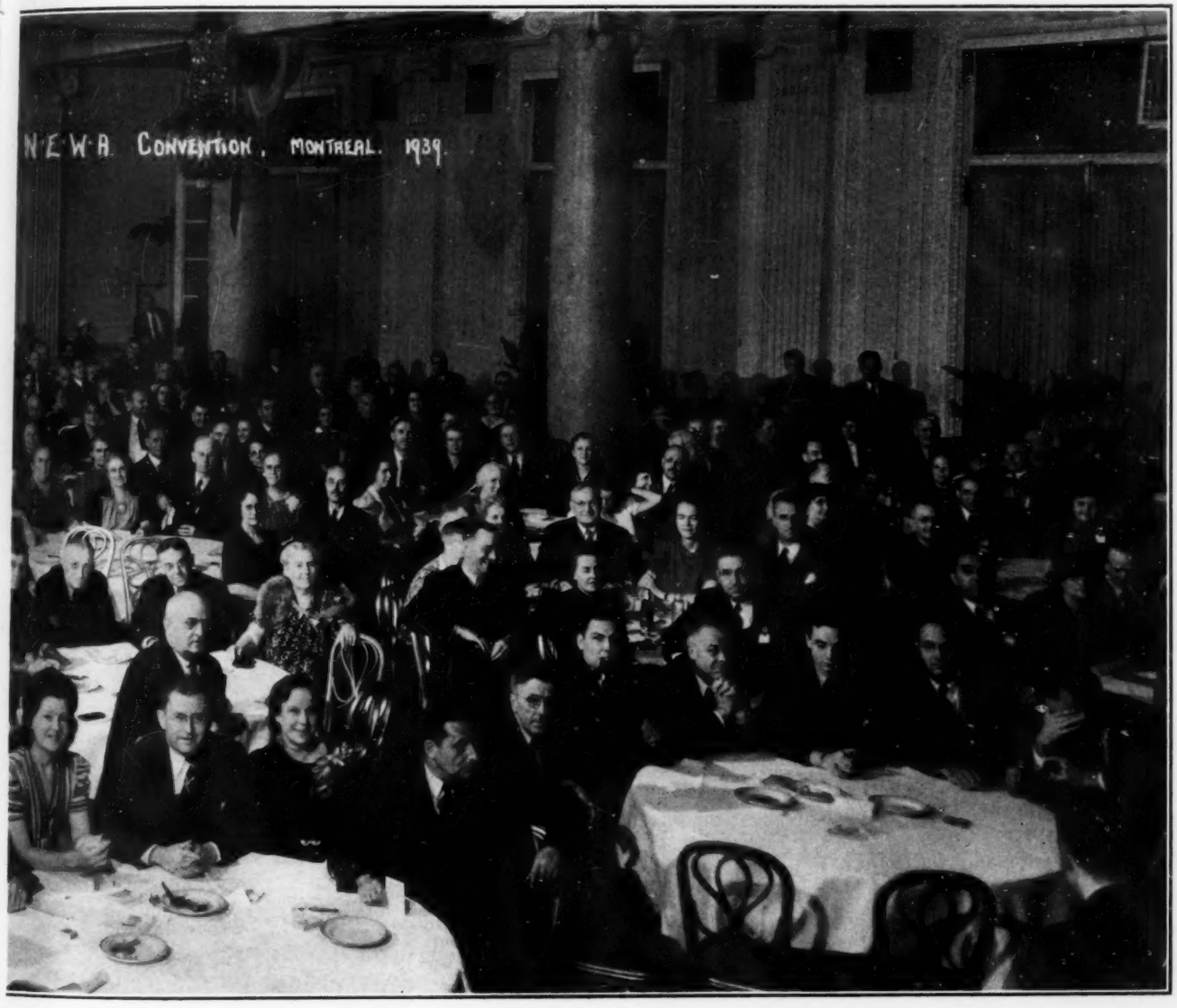
New Anti-Corrosion Treatment

"Sodium Hexametaphosphate as an Aid in Corrosion Control" by OWEN RICE, Research Engineer, Hall Laboratories, Pittsburgh, Pa.

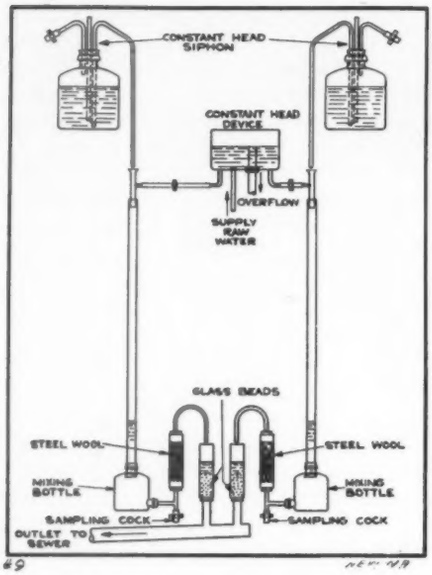
Mr. Rice led up to his principal topic with a brief review of the role played by small applications of this remarkable compound, sodium hexametaphosphate, in preventing scale formation in pipe lines by checking the deposition of calcium salts, also the precipitation of calcium soap in laundry or bath waters. Likewise, in dosages of 4 p.p.m. iron, manganese and other metals are held in solution by the compound. In its adaptation to municipal water treatment, for holding calcium carbonate in solution and maintaining pH values in lime treatment for corrosion control, it had been noted that applications of between 1.5 and 2 p.p.m. of the compound cleared up red water in the far reaches of the system. This observation and the lack of rusting of bare metal spots in cleaned pipes, led Hall Laboratories into investigations which revealed that hexametaphosphate apparently has the power of producing a protective film on metallic surfaces. Such was demonstrated with the apparatus exhibited by Mr. Rice and here illustrated. The result revealed that fresh steel wool remained bright in flowing water treated with hexametaphosphate (hereafter referred to by the shorter trade name "Calgon") whereas the same water untreated rusted the wool in a brief time and stained glass beads over which it flowed. Apparently, the protective film theory holds in view of the fact that after "Calgon" treatment has been stopped it was some time before rusting of the steel wool was observed. Resuming treatment, cessation of rusting was not immediate at dosages below 4 p.p.m. but gradually became less as the assumed "plating" progressed. Likewise a 24-hour application of "Calgon" at the 4 p.p.m. rate allowed a drop to 2 p.p.m. thereafter, without rusting resulting.

Citing results in treating corrosive Pittsburgh water (pH 5.6), when evaluated on the basis of dissolved oxygen depletion (assumedly going to rust formation), "Calgon" treatment had effected an 80% reduction in corrosion.

H. T. GIDLEY, Supt., Fairhaven (Mass.) Water Co., reported that under the direction of Robert Spurr Weston "Calgon" treatment had re-



Night Smoker, Featuring "The Drunkard"



Corrosion Indicator for Comparing Water Treatment Effectiveness
(See Rice discussion of "Calgon" Treatment.)

cently been started and apparently began to show effects on the third day of treatment at the rate of but 1 p.p.m. Evidence was based on the flushing of dead ended mains. Interesting was a consumer's remark concerning the better lathering quality of the water. (Since the water of Fairhaven was so very soft, Mr. Rice remarked that he could hardly believe that "Calgon" could be credited with any soap reduction.)

In reply to questions, Mr. Rice said that he preferred not to make specific recommendations during this feeling out stage of the treatment and suggested that the simple steel-wool test apparatus would reveal the extent of dosage required for every specific condition. He felt it preferable to apply the treatment continuously at the minimum effective dosage, rather than an intermittent higher dosage and probably less uniformity of results. The treatment could be applied in conjunction with lime for pH boosting or alone. Most plants were employing lime when the "Calgon" treatment was begun. Fairhaven was not using lime and he considered lime of questionable value when using "Calgon". Mr. Rice was not certain that the treatment would prevent attack of copper tubing by highly corrosive waters, but with continuous use the possibility was that it would. At the Fairhaven rate of 1 p.p.m. dosage the cost was $1.40 per million for the hexametaphosphate. Being corrosive the solution should be fed with pumps such as are employed in feeding hypochlorites.

(That considerable interest existed in the steel-wool rusting demonstration, and "Calgon" anti-corrosion treatment, was evidenced by the fact that group discussion was continued even after official adjournment. —Ed.)

Concerning Lead for Services

"Conditions Covering the Installation of Lead Service Pipe" by Robert L. Ziegfeld, Lead Industries Association, New York City.

Mr. Ziegfeld cited the increasing demands on service pipe, including higher pressures, water hammer, electrical grounding, and corrosivity of treated water. He then cited the properties of lead which made it an ideally suitable material when meeting modern specifications which permit it to be stamped with Lead Industries' Seal of Approval. Outstanding amongst the advantages of lead was its permanent flexibility, which required that for service pipes the lead employed be at least 99.7% pure and the zinc content not more than 0.002%. Based on wall thickness the three classes of service pipe were 50-lb. pipe (Class A); 75-lb. pipe (Class A.A.); 100-lb. pipe (Class A.A.A.). Since the wall thickness and uniformity had been increased, it was no longer necessary to specify thickness beyond the new standards.

How Come the Membership's a Droppin?
Harold Brigham, Sup't. Water & Sewage, Marlborough, Mass. (N.E.W.W.A.'s Top Director). Miss Cornelia Sachs, Asst. to Secy. Gifford [They must have chosen her to keep Frank on the job and get Chase to committee meetings]. Don Calderwood, Engr. & Ass't. Supt., Nashua, N. H. [Chairman of Committee on Emergency Procedures.]

Concerning resistance to external corrosion, muck and cinders proved the most corrosive soils. On the other hand salt marsh attacked lead but little if any, due to the formation of sulphate and sulphide film protection. On the other hand free-lime and green concrete was detrimental to lead. Concerning electrolytic attack, since lead was such a poor conductor (8 as against 100 for copper) stray ground currents are not readily picked up, later to leave at some point and cause localized pitting.

Coming to the matter of internal corrosion, Mr. Ziegfeld stated that lead suffered in this direction just as other metals did, only to a lesser extent. He indicated that except for the lead poisoning bugaboo, little would be heard of corrosion troubles with lead, because corrosion of lead services neither resulted in chokage of the pipe or failure due to pitting, nor did it produce water discoloration or tastes or odors. As with competitive metals, the solution of the lead attack problem lay in treatment of the water by modern methods or employing tin lined lead. As to the fears of cumulative lead poisoning, Mr. Ziegfeld cited medical authorities who had proved that lead was not cumulative in the human body, as at one time assumed, therefore the U. S. Treasury limit of 0.1 p.p.m. lead in potable waters constitutes a decidedly safe limit and was readily procurable with effective anti-corrosion treatment. In Massachusetts the State Dept. of Health had found only 4 out of 300 public water supplies in the State attacked lead sufficiently to cause lead poisoning. However, in general, said Mr. Ziegfeld, waters of less than 50 p.p.m. hardness, of low pH value, or high in carbon dioxide and oxygen, should be watched for plumbosolvency, and especially so if the water is of a peaty nature and high in organic acids. Such waters required that effective treatment be provided.

Returning to the physical attributes of lead pipe, Mr. Ziegfeld advocated the use of a liberal horizontal goose neck at the main and, for long services (100 ft.), a smaller one at the wall of the building. His paper contains a table of goose neck dimensions for various diameter services—2 ft. for 1 in. up to 6 ft. for 2 in. Class AAA pipe. The main should preferably be tapped on the side for making the proper goose neck. Of the methods of jointing (wiping, cupping and soldering, and compression couplings) the shop made wiped joints was to be preferred, but the other types were being successfully used. Another attribute of lead services cited is their role of "safety-fuse," since lead will fail under severe water hammer before more serious damage is done to the rigid parts of the system.

In the discussion which ensued it developed that tin-lined lead pipe has been used by water utilities to

(1) *Col. Thomas Wiggin, Cons. Engr., N. Y. City and Mrs. Wiggin;* (2) *Henry and Eleanor Solomon, L. A. Solomon & Bros., N. Y. City;* (3) *Francis Hersey, Hersey Mfg. Co., South Boston, and Mrs. Hersey;* (4) *Wm. P. Melley, Sup't. of Water, Milton, Mass., and Mrs. Melley;* (5) *Harold Brigham, Supt. of Water & Sewage, Marlborough, Mass., and Mrs. Brigham.*

some extent but no one seemed to know the additional cost of such lining. The question of what zone of pH values, as a rule, resulted in the lowest plumbo-solvency was raised. To this question, asked because of observations that lime treatment had been observed to increase lead attack when applied beyond the point of carbon dioxide elimination, no answer was available. (If any of our readers can supply the answer to this seemingly important question, we shall appreciate hearing from them.—ED.)

At this point it was brought out by Mr. Kingsbury of the Mass. Dept. of Health that by actual survey it had been revealed that water remained in distribution systems surprisingly long—actually 9 to 21 days before reaching some outlying consumers. These periods were first computed from pipe sizes and meter readings. Later when lime treatment was commenced the time for the effects to reach consumers' services checked with the computed periods which seemed unbelievably long.

Mr. Kingsbury also commented on the galvanic couple effect from connecting lead with other metals which had been responsible for aggrivated plumbo-solvency and suggested insulating at such joints if it proved necessary to bring the two dissimilar metals together. He also revealed that a private owner of a spring had reduced lead attack materially by merely filling his spring reservoir with limestone chips to reduce aggressivity by hardening of the water.

L. H. ENSLOW, Editor, "Water Works and Sewerage", believed that the scheme of stabilization of aggressive water by its passage through contact beds of limestone or marble chips to be the most practical and economical scheme yet devised for use in connection with small to medium sized systems, and most definitely so for institutional, resort and private systems. Regardless of the nature of materials in the system the scheme had equal merit, in that it may be classed as "automatic". There is no danger of over-treatment with the limestone scheme, because the water will satisfy its appetite for the stone and no further action ensues. The maximum pH value will be 8.2 after overnight contact periods, and lesser values as the contact period decreases. [After the session it was learned that two sources of limestone or marble in New England are The Rockland-Rockport Lime Co., Rockland, Maine, and The Vermont Marble Co., of Proctor, Vermont.]

MR. C. L. POOLE, Chief Engr., Rhode Island Dept. of Health, stated that raising the pH value to a point above 7.2 had sufficiently corrected plumbo-solvency of one water to his knowledge.

"Some Significant Experiences in Water Treatment" by CHAS. R. COX, Chief, Bureau of Water Supply, N. Y. State Dept. of Health, Albany, N. Y.

Mr. Cox's well prepared and highly interesting paper revealed three significant recent experiences in water treatment in New York State, involving unusual conditions.

The first experience recounted was that with an ozonation plant at Delhi, N. Y., (1800 population) installed at the local filter plant in 1928 by the Electrozone Corporation of New York City. The process when properly operating, and when sufficient ozone could be added, proved highly effective in destroying organic matter and tastes in a good quality of filtered water. However, the low solubility of ozone created difficulties and required excessive re-pumpage of water, entailing an additional pump and operating cost of $1800 per year. The initial scheme of dissolving all of the ozone in a partial flow for mixing with the major flow did not prove possible. The original estimate of 0.5 p.p.m. ozone being adequate, at a production cost of 20 to 30 cents per pound from requisite current at 2 cents per K.W.H. (60 grns. per K.W.H.) proved insufficient. The changing ozone demand of the water proved another difficulty in operation control. It was estimated that an installation to provide adequate and dependable ozonation at Delhi (1800 population) would have cost $20,000 for the equipment and $12.00 per day for current at 2 cents per K.W.H. The cost seemed too excessive in comparison with automatic chlorination equipment which has since been substituted.

In summary, Mr. Cox stated that the disadvantages of the ozonation process for the smaller community without expert supervision far outweighed the admitted advantages such as organic matter destruction and freedom from taste and odor troubles. The technical weakness in the process lies in the solubility of ozone which is below the concentration required for effective results on many waters. And the process is lacking in a satisfactory control measure, such as is found in the residual chlorine test.

(1) *Chas. L. Pool, Chief Engr., R. I. State Dept. of Health, Mrs. Pool and Theo. La Freniere, Chief Engr., Quebec Provincial Dept. of Health, Montreal;* (2) *T. W. Dix, Supt. Public Works, Barre, Vt., H. R. Prescott, Eddy Valve Co., Waterford, N. Y., and Geo. E. Hawkins, Supt. of Water, Brattleboro, Vt.;* (3) *Roger C. Oakman, Supt. of Water, Needham, Mass., and Mrs. Roger;* (4) *Chas. W. Baldwin, Simplex Valve & Meter Co., Boston; Jimmie Angell, Eastern Mgr., "Water Works & Sewerage," N. Y. City and Jas. J. Vaughn, Chief Engr., Norwood Engineering Co., Northampton, Mass.;* (5) *"Vic" Arnold, Pres. Phoenix Meter Corpn., N. Y. City and Mrs. Arnold.*

Experience No. 2: The second experience cited by Mr. Cox was that of heavy raw water chlorination and dechlorination through granular carbon beds at South Fallsburg, N. Y. The plant consisted of two pressure sand filter units operated at 3 gal./sq.ft./min. followed by one granular carbon pressure unit operating at 6 gal./sq.ft./min. Lacking coagulating and clarification facilities the high rate scheme proved unsuccessful and the granular carbon soon became coated over with impurities adsorbed from the ineffectively filtered water. Although the carbon bed continued to remove the 0.5 p.p.m. chlorine residual in the filtered water tastes were not removed after the first 60 days of operation. The chlorine dosage varied between 1 and 6 p.p.m. [applied to the raw water] and the results proved the inherent advantages and safety resulting from such high chlorination practice and dechlorination.

In summary, Mr. Cox stated that the experience indicated the effectiveness of granular carbon as a dechlorinating material far beyond its exhaustion as a taste (organic matter) absorbent. Thus the applicability of the procedure wherein exact chlorine dosage control is eliminated and insurance is had of efficient disinfection, under all conditions of flow and quality changes, had been effectively demonstrated.

Experience No. 3: The third experience had to do with a well water of extreme hardness (1400 p.p.m.) and the results of zeolite softening at Elba, N. Y. The water containing 1200 p.p.m. sulphate hardness produced hydrogen sulphide and black water (sulphide of iron) in the mains as the outcome of oxygen deficiency resulting in bacterial break down of sulphates. This difficulty was corrected by aeration but the softened water (225 p.p.m. alkalinity; pH 7.1; total hardness 40) then became highly corrosive, picking up 4.6 p.p.m. iron from the mains. Also the iron precipitated by pre-aeration ahead of the zeolite units resulted in chokage of the beds and likewise incomplete removal of the oxydized iron. These difficulties were corrected by substituting for the aerating air-lift a deep well turbine pump. Mild aeration of the new iron free zeolite effluent was provided with coke-tray aerators. Caustic soda (6 p.p.m.) and silicate of soda (6 p.p.m.) applied to the finished water to produce pH values between 7.8 and 8.5 has proved effective in checking corrosion as measured by pick up in iron content in the mains.

Owen Rice, Research Engr., Hall Laboratories, Pittsburgh. Frank Dorrance, Div. Engr., Montreal Water Board. Franklyn Lammers, Sales Engr., International Filter Co., N. Y.

These experiences, explained Mr. Cox, have been cited to indicate the need for experience and understanding in water treatment when unusual conditions are met with; likewise, the fallacy of attempting to employ make-shift methods for economy sake; and, further, the high cost of installing unproven or complex equipment requiring expert supervision such as the smaller communities rarely have available.

Waterworks Practice in England

One complete session was devoted to the featured topic on the program — "Waterworks Practice in England" — the title of a paper which was scheduled to be presented by *John Bowman*, Water Engineer of the City of Edinburgh, Scotland, and now president of the British Institution of Water Engineers. This featured paper, with planned discussion by an array of outstanding members of the Association, was arranged between the N.E.W.W.A. and the Institution of Water Engineers as an exchange paper. In the reciprocal agreement on alternate years a paper by a N.E.W.W.A. member is presented before the British association, the most recent American paper by Caleb Mills Saville having been awarded a prize by the Institution of Water Engineers.

Because of war developments it proved necessary for Mr. Bowman to cancel his plans to come to America at the last minute. His highly interesting paper, read by *E. Sherman Chase*, pointed out that the British Isles, with roughly but twice the area of New England, was prevalently mountainous and afforded many important upland water sources and large storage reservoirs. Concerning rain-fall, Scotland's average is 50 in. per year and some spots actually record 200 inches. In England the average is 188 rainy days; in Scotland 217. Evaporation averages but 14 in. per year, ranging from 11 to 17 inches. It was a surprise to learn that in Scotland and Wales there are no private water companies. In England profits by such companies are limited to 6% return on the investment. Although the New River Company supplied London in 1613 and Edinburgh had a municipally-controlled undertaking in 1676, in general the development of proper and systematically planned water supplies was begun in the British Isles only in 1845 and the riparian law still required release of compensation water amounting to 33% of the average daily yield—a much discussed and criticized requirement. Then, too, in developing ground water supply, municipalities must secure governmental approval of the taking, whereas industry and private companies are permitted to take ground water at will and without regulation, for process use *or for sale*. Regarding such unsatisfactory conditions, the whole question of planning underground and surface supplies is receiving the attention of a Central Advisory Committee set up by the Ministry of Health. The same committee is also looking to the consolidation of all laws relating to water supply and the first draft of a bill has already been submitted by it.

Concerning purification of waters, many supplies on the Islands require no purification. For instance during the past 80 years Glasgow, the second largest city in the British Empire, has supplied impounded upland water without purification of any sort and without record of waterborne outbreak in the 80 years. Other important cities, however, provide filtration and more recently, stated Mr. Bowman, the trend has been to chlorination as well—including ground waters also. To some extent ozone is also being employed. Water consumption per capita in the 6 most important cities of England varies between 37 and 49 U.S. gals. per day per head. In Scotland the requirements run from 46 gals. upwards to the 90s, depending upon the ratio of domestic to commercial takings.

It was interesting to hear that until recently there were no official standards for water fittings, resulting in inferior products due to sharp competition. More lately there has been produced a standard set of specifications by the British Waterworks Association, which brought

(1) Carolyn Brehm with her "Daddy," (George C.), past-president of N.E.W.W.A. and now Supt. of the Amherst (Mass.) Water Co., and Mrs. Brehm; (2) Henry Armbrust, Proportioneers, Inc., Providence, R. I., and M. A. Goboury, Chemist, Quebec Dept. of Health; (3) Paul Hansen, of Greely & Hansen Engrs., Chicago, taking a squint at "what's new" in Crane's booth (in Chicago he doesn't have time); (4) Part of W. & T. Family—Eddie Rothman and Mrs. R. from Bridgeport, Conn.; Jacques Benoit (W. & T.'s Montreal office) and Mrs. Benoit; (5) Thomas Kennedy, Supt. of Water, Fitchburg, Mass., Mrs. Kennedy, and "Reggie" Hayes, of Boston, who sells "Hydrotite" in New England.

such strenuous objections from the manufacturers as to cause the Ministry of Health to develop a less stringent set of specifications. The situation is not good, said Mr. Bowman, and has resulted in two sets of standards in use, and puts a burden on manufacturers who now must supply fittings to meet both the B.W.A. and M.O.H. Standards. There is need and hope for a composite single set of adjusted specifications.

With regard to pipe lines, the introduction of dependable bituminous coatings and linings has put steel pipe back into the picture for the larger mains. Cast-iron, so prevalently employed in the past, continues to be favored for distribution systems, more particularly the modern cement-lined cast-iron which is centrifugally cast. Also, asbestos-cement pipes have come into use in the smaller sizes.

Lead service pipe is still prevalently employed in British practice but copper tubing has become a formidable rival. Interesting is the fact that hot water systems in even the modern residences are supplied from a small feed cistern of about 10 gals. capacity, which is fed from the mains. In the older houses a similar cistern supplied all of the services. [No hot water damage to British meters! And herein may lie a satisfactory solution to the back-syphonage problem.—Ed.]

As to fire fighting, service mains are undersized. Movements toward providing better fire fighting facilities will require installation of parallel mains or replacements with larger pipes in numerous British systems.

In respect to preparation to safeguard British water supplies against air raids, Mr. Bowman recited what has been done in Edinburgh. Every man has been trained to work in anti-gas clothing, with emergency duties allocated to every employee. Emergency repair depots have been established at strategic points. Many duplicate mains have been laid and more adequate valving introduced on both old and new mains at a cost of $125,000—50% being from a government subsidy to the city.

Amongst the scheduled discussors of Mr. Bowman's paper, William Storrie, Toronto Consulting Engineer, was prevented from appearing due to war pressure.

Caleb M. Saville, Chief Engr., Water Bureau, Hartford, Conn., in an absentee discussion, said that although London is 631 miles further north than Boston, the Warm Gulf Stream made matters much more pleasant for British waterworks men. Also the latter made for abundant precipitation. When fully metered, American domestic consumption was not much more than the British. Notwithstanding Mr. Bowman's remarks, he considered Great Britain ahead of America in respect to standardization of fittings. In the matter of service pipe materials his experience indicated that neither lead nor copper was as satisfactory in the more corrosive waters as was cement lined pipe.

Col. Thomas H. Wiggins, Consulting Engineer, New York, having visited the British Isles 2 years ago, remarked that our cousins across the sea treat their countryside more kindly than do Americans; that Scotch waters were even softer than those of New England and treatment practices were much less involved than in America—in fact were much less. In Glasgow he had inspected some very old C.I. pipes laid in 1821 and others were 200 years old. He had been surprised to find socalled fire hydrants on 2 in. lines. He also told of witnessing the successful reconditioning of small C.I. mains (3 to 5 inch) involving cleaning and lining with cement mortar in place by the Tate Process, now being introduced in America.

E. Sherman Chase, Consulting Engineer, Boston, Mass., said that stream gaging in England was less than in America. The long storage of London waters in shallow reservoirs had deleteriously affected water quality and created algae difficulties. English practice had been to let the whole contract for filter plants to purveyors of filter equipment who assumed responsibility for satisfactory performance of the completed plant.

W. W. Brush, Editor, "Water Works Engineering," commented on the smaller flush tanks in British bathrooms and therefore reduced consumption in this major domestic usage. He had found water waste prevention work in England more thorough than in America. A number of supplies were found posted as "unsafe" by means of signs in hotel rooms, but in very small letters.

Frank Y. Dorrance, Div. Engr., Water Board, Montreal, reviewing the history of water supply development in Montreal, commented on the wisdom of taking St. Lawrence River water in preference to a mountain supply involving a 90 mile supply line and limited yield. The filter plant, built in 1907, incorporated double filtration—the primary being rapid sand, and the secondary slow sand units. With the establishment of chlorination as a thoroughly dependable process, double filtration had been abandoned.

Other discussors were R. S. Weston, Karl R. Kennison, and E. J. Cleary.

To Appear in the Next Issue

In the second half of this report, to appear in our November issue, the following will be briefed.

"Some Phases of Public Relations"—H. L. Brigham.

"Some Problems of Winter Operation"—A. K. Grimmer.

"Protection of Standpipes"—H. G. Hunter.

"River Crossings"—G. T. Heeney.

"Construction and Operation of Rapid Filters at Lawrence, Mass."—E. S. Chase.

"100 Years in the Water Works Field"—S. W. Kitson.

"Appraising P.W.A. and W.P.A. in New England"—W. W. Brush.

"New Priming Systems for Use with Centrifugal Pumps"—F. A. Broadhurst.

"Backflow in Plumbing Systems"—R. H. Zinkil.

MAINTENANCE OF WATERWORKS EQUIPMENT*

By SHERMAN L. ROGERS
District Engineer
Water Bureau
HARTFORD, CONN.

Now, in the building of chaises, I'll tell you what,
There is always somewhere a weakest spot—
In hub, tire, felloe, in spring or thill,
In panel, or crossbar, or floor or sill,
Find it somewhere you must and will
And that's the reason beyond a doubt
That a chaise breaks down but doesn't wear out.

OLIVER WENDELL HOLMES wrote the above lines many years before most of our modern machinery was even thought of. The moral in the poem is still more or less true, but I think that the statement that machinery "breaks down but doesn't wear out" is slightly inaccurate.

In waterworks operation, it is most important that machinery and equipment be in best possible condition for instant use, especially emergency equipment which may be required at any moment to control or repair breaks in large pipe lines.

Emergency Truck and Tool Trailer.

To control a break similar to one which occurred in a 30″ cast-iron main in West Hartford last winter, we have a 1½-ton truck equipped with maps, gate locations, gate wrenches and other tools.

A gate-closing mechanism for closing down the larger valves with the truck motor is also installed on this truck. With this mechanism a 30″ gate which would ordinarily take four men 30 minutes to close by hand can be closed in 10 minutes (see Fig. 1).

This particular break, in which one length of 30″ pipe split from end to end, occurred at about 10 a.m. and service was completely restored within 9½ hours. To accomplish speedy repair work like this, we keep a trailer tool box at our main yard, completely equipped with boots and enough hand tools to get repair work well under way. This eliminates delay while tools are being assembled from various jobs.

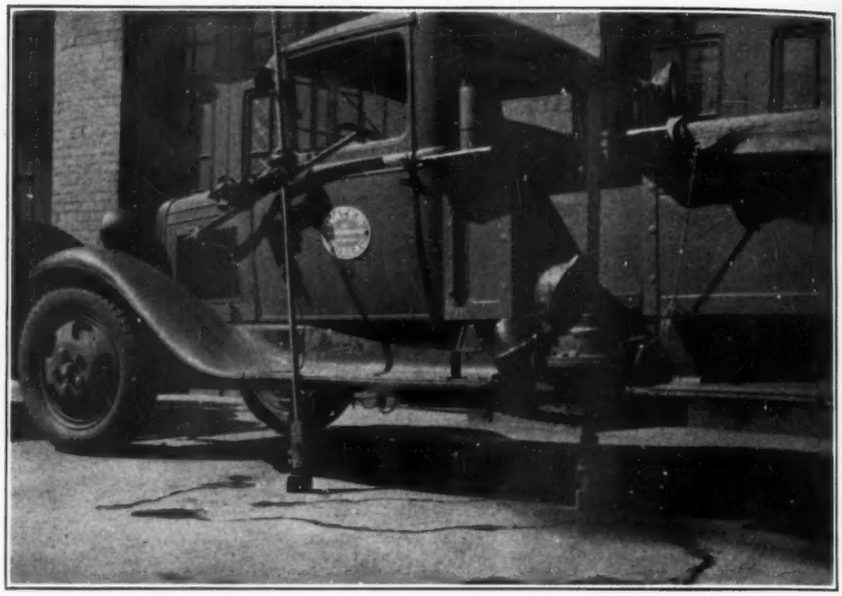


Fig. 1: Emergency Truck with Motor-Operated Gate Mechanism (right) and Air-Operated Gate Wrench (left)

Compressors and Air Tools.

Since a large proportion of our main streets have a concrete base, an air compressor is usually needed to break down the pavement. We have five compressors and a Barco gasoline driven paving breaker. Two of the compressors are truck-mounted portable units and three are powered from the motors of the trucks on which they are mounted. Each compressor carries two paving breakers, two clay diggers, two tampers, a sump pump, and those on main pipe work also carry air-caulking and chipping hammers.

The latest addition to our fleet of compressors is a 134-inch wheelbase Ford with the cab over the engine which also furnishes power for the compressor unit. The inside of the body is equipped with seats for the men and bins to carry various fittings used on service pipe work.

Before a system of periodic tests and checkups was inaugurated, it was a frequent occurrence to have an air tool break down when most needed, or else have the foreman complain that the compressor assigned to him was no good because it would not run two paving breakers. Each operator now brings his compressor to the shop for a four-hour inspection and checkup every fifth week. The air output is first measured on the air meter to determine its efficiency. Air consumption tests are then made on the air tools while the mechanics check over both compressor and truck engines. On power takeoff units, the speed of the compressor is also checked, since this depends on the setting of the governor and needs occasional adjustment for proper operation. Oil is changed, plugs, distributor and carburetor cleaned, and the whole outfit tightened and inspected.

Testing and Repairing Paving Breakers.

The air meter is shown (Fig. 2) with a paving breaker connected for a test in the lead pot. The hose of the compressor is connected to the meter through the connection at the left in the illustration. A flat-pointed moil point is placed in the breaker and worked in the lead for 10 seconds. The air consumption in cubic feet of free air per minute is meanwhile being noted from the

[* A paper presented before the New England Water Works Association, and reproduced by permission of the Association.—Editor]

meter. A 2-inch penetration into the lead is required with an air consumption not exceeding 68 cu. ft. per minute. The breakers which we use were originally rated to take about 55 cu. ft. of air per minute when new, but this gradually increases with wear. When making our first tests, we found several hammers which took 80 cu. ft. or more of air per minute, or 75% of the total output of the compressor. A breaker such as this appears to do as much work as ever, but if two such breakers were connected to a 105-cu. ft. compressor something would appear to be wrong right away. Formerly it was the compressor which took the blame instead of the breakers.

Excessive air consumption can sometimes be reduced by taking the air tool apart and cleaning it, but if it has been used without oil and the cylinder is scored, or if it is badly worn, it is necessary either to install oversize pistons or have the cylinders built up by the chrome process, which is very satisfactory, and the cost is approximately half that of a new paving breaker. Oil is very important in the operation of paving breakers, and we insist that the oil reservoirs in the handles be filled at least twice a day. During cold weather, three gallons of oil are diluted with one gallon of kerosene and one gallon of alcohol. The alcohol prevents the tools from freezing and the kerosene serves to dilute the oil and makes it mix with the alcohol more readily.

The clay diggers and tampers are given an air consumption test, while the sump pumps are tested in a tub of water. Air consumption alone is a fairly accurate indication of the amount of water a pump will lift. We find that the pumps require about 80 cu. ft. of air per minute to handle 180 g.p.m., while the clay diggers require about 33 cu. ft., and the tampers, 28 cu. ft. per minute.

Maintenance of Automotive Equipment

Automobiles and trucks are also inspected at monthly intervals. This has proven to be a very good investment. Since inspections were started, there has not only been a decided improvement in the general condition of the units, but breakdowns on the road have been much less frequent.

All cars are washed and greased bi-weekly by the night emergency men, and after every second washing are kept in the shop the next day to allow a mechanic to go over the unit, tighten the chassis, adjust

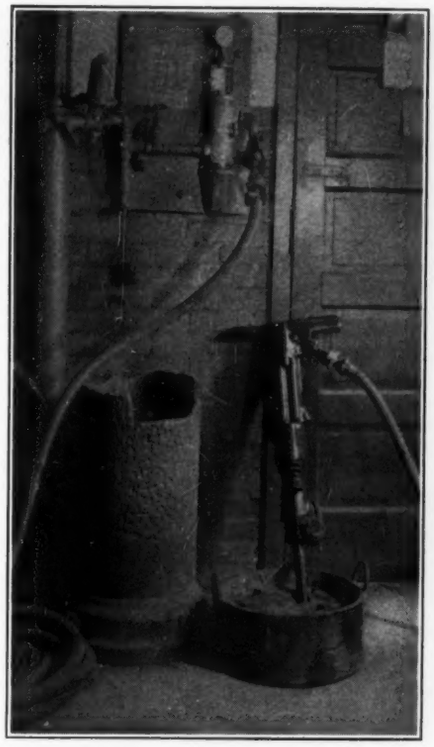


Fig 2: Paving Breaker Under Efficiency Test
(Air-meter on wall above)

brakes, carburetors and other equipment. Defects which cannot be repaired in the four hours allotted to the mechanic to work on the car are reported to the foreman, who makes arrangements for the work to be done at a later date. In this way the yard foreman has a definite knowledge of the condition of the cars and there is no excuse for breakdowns.

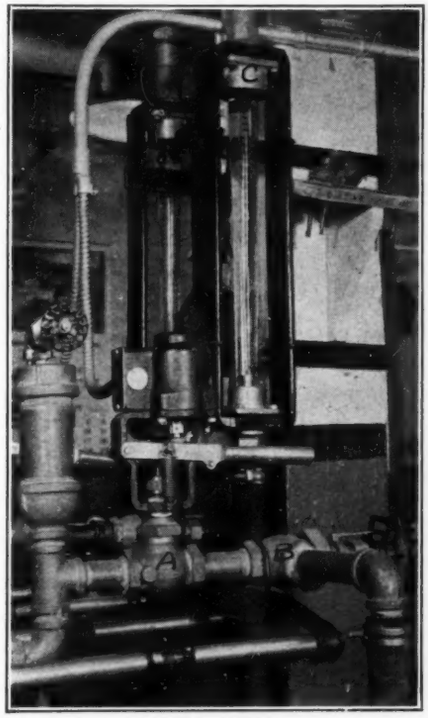


Fig. 3: Equipment for Automatic Meter Test Run
("A"—Solenoid Valve; "B"—Flow Control Valve; "C"—Ford Testerate Indicator)

The cars are all equipped with oil filters and oil is changed only twice a year. The filter cartridges are changed whenever they become dirty, which varies between 4,000 and 6,000 miles, depending on the condition of the motor. At one time we had about fifteen drums of crankcase drainings. To use up this old oil a Skinner Oil Filter was set up in our filter plant, where our own electricity is available. This filter takes the impurities out of the spent oil and its output is about 2 gallons per day. The filtrate, with an SAE number of about 30, has been used successfully in the older trucks, now for about two years.

The average cost per mile for operating 23 half ton pickup trucks was 3.65c per mile last year, and for operating eight 4-ton trucks, 6.3c per mile. These costs include office overheads, insurance and tires, but do not include depreciation.

All pumps. large main-tapping machines and similar equipment are checked after being used. By this procedure, all equipment is kept in a condition to operate at all times.

Meter Shop Practices.

Much the same procedure is followed in the care of meters. We plan to bring into the shop each year one-fifth of all our meters. This program, which was started in 1932, was completed for the first time in 1936 when we tested over 9,000 meters.

Although we now have 2,160 more meters than in 1934, last year 467 fewer meters were removed for all causes, other than routine tests, than in 1934. We believe that this improvement is largely due to eliminating the weak links before they break down.

Used Meters Must Meet New Meter Accuracy.

Upon arrival at the shop all meters are tested at a rate of ¼ their rated capacity, after which each meter is torn down, washed, and reassembled with necessary new parts. Every repaired meter is then tested and must meet the requirements of the NEWWA specifications for accuracy of *new* meters.

All worn gear trains are repaired in the shop and certain of the chambers are remachined and pistons refitted to the chambers. Other cham-

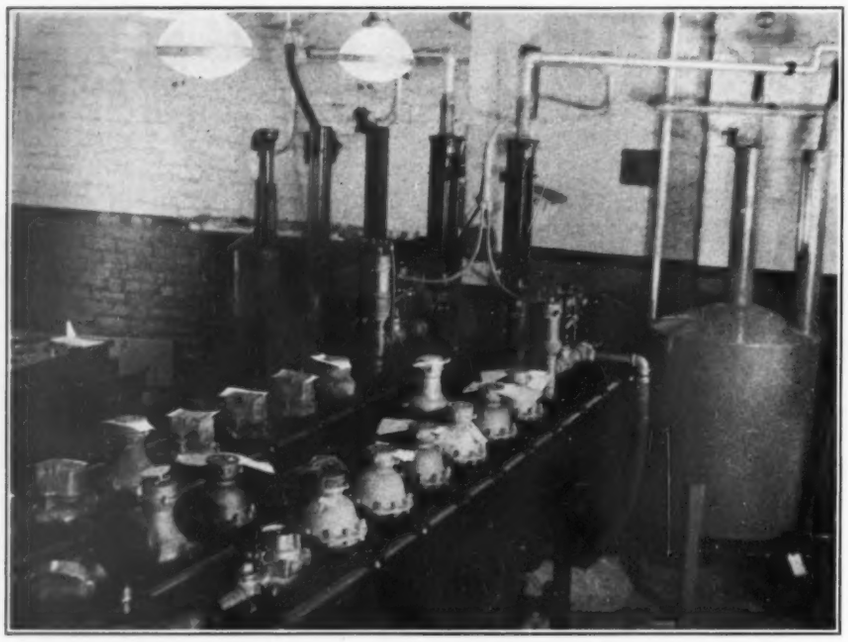


Fig . 4: View of Meters Connected to Rate Indicator and Solenoid Valve at End of Bench (Fig. 3)

(10 cu. ft. and 1 cu. ft. measuring tanks on right and left.)

bers are repaired at the various meter factories, if we cannot quickly fit new discs to them ourselves. When repaired meters were first required to meet the NEWWA accuracy requirements for new meters, it was necessary to revise our testing procedure. Previously, on the minimum test flow, which in the case of a ⅝-inch meter is 0.25 g.p.m., we ran water at this rate through the meter for three minutes. For a 100% registration, the meters should read 0.1 cu. ft. Since it was almost impossible to differentiate between 0.08 and 0.09 of a cu. ft. and since 0.09 was required for the meter to pass, it was necessary to run a full foot of water into a one foot test tank. This takes 30 minutes, and it seemed a waste of time and labor to have a man spend a half hour watching water run into a can.

Automatic Meter Test Run.

The present electrical apparatus (Fig. 3) was rigged up to meet this condition. The flow is now started by opening a solenoid valve. When the test tank is filled a float in the tank closes an electrical circuit which trips the valve and shuts off the water. The volume in the tank is controlled by this means to within 1/10th of 1 percent. By this means it is possible for one man to test two strings of 8 meters, each simultaneously, and on each flow enough water is run so that the test hand of the meter always makes at least one complete revolution.

In Fig. 3, the water goes through the meters which are at left of the picture, thence through the solenoid valve "A" and the flow control valve "B" to the Ford Testerate Indicator "C", (shown above valve "B") and then to one of two tanks shown in Fig. 4. The large one is of 10 cu. ft. capacity and the smaller one holds 1 cu. ft. Each has a conical bottom and a reduced section at the top for greater accuracy. One of the two pipes coming out of the top of the tanks is used for filling, and the other contains the float.

This work is under the direction of Caleb Mills Saville, Manager and Chief Engineer of the Water Bureau of the Hartford (Conn.) Metropolitan District, and of Harold W. Griswold, Deputy Manager and Deputy Chief Engineer.

WHY NOT A SUGGESTION SYSTEM?*

For Water and Sewage Works

A well known American concern recently awarded a prize of $300 to one of its employees for simply suggesting the use of soot blowers on the concern's boilers.

The matter of soot blowers was investigated, they were installed, and in a short time the investment proved so profitable that the officials of the concern decided that the *mere suggestion* was worth $300.

Probably you need soot blowers; probably you don't! You very likely need *something* which may more than pay for itself in a short time. After paying for itself it becomes an actual "earner." Executives and managers can't possibly think of everything. Even with the paid cooperation of every employee many good things will surely slip by. So, why not reward *outsiders* for worth while suggestions, as well as employees?

Many water and sewerage officials may not know that in 1894 John H. Patterson, founder of the National Cash Register Co., originated the modern "suggestion system." It worked so well in his own plant that many institutions of today have adopted the idea. Employees are invited to drop suggestions into boxes that are provided in several places about the plant. Every suggestion is considered, and those adopted are paid for.

It is usually found that the suggestion system is decidedly profitable.* I have before me a report concerning one large company which considered over 12,000 suggestions in one year and adopted over 3,000 of them. The amount of money paid for each suggestion averaged nearly $13.00. It was estimated that each suggestion during one year effected an average earning of over $130.00. Based on the amount earned per suggestion it is easy to figure that the total earnings during that year alone amounted to about $400,000.

My suggestion here is, as already stated: let the world know that you will gladly give prize money to *anybody* who suggests a money-making idea. And, don't eliminate the outsider in so doing.

[*In itself a worthy suggestion from W. F. Schaphorst, Consulting Mechanical Engineer, Newark, N. J. We know of water and sewage works systems on which the scheme has been tried. It has proved very effective and valuable to all concerned. Opening the "suggestion-box" to "outsiders" is, however, a new and interesting idea. By such a scheme "consulting advice" may cost a mere pittance in comparison with value.—Editor.]

DETERMINATION OF THE pH OF WATER

By F. R. McCRUMB
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BALTIMORE, MD.

THE widespread use of pH control in the treatment of water for drinking purposes, for swimming pools, for steam generation and for numerous wet processes makes it worth while to examine the possible accuracy of the testing methods employed. Two general methods are in use, the electrometric (potentiometric) and the colorimetric.

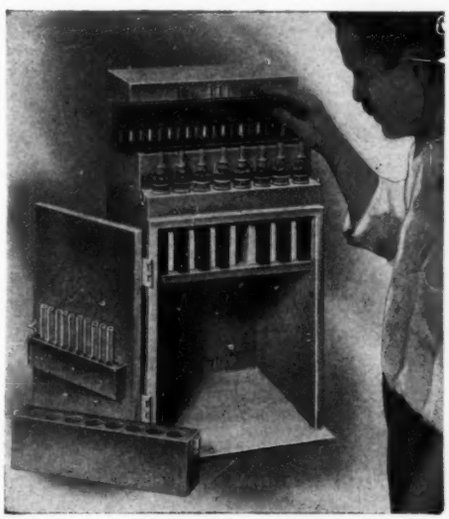
Electrometric Methods—

Electrometrically, pH is determined by measuring with a potentiometer the voltage developed by two electrodes both in contact with the sample. The voltage of one electrode is fixed and known (calomel half-cell), the voltage of the other varies with the pH of the sample. Three variable electrodes may be used, hydrogen, quinhydrone or glass.

The hydrogen electrode consists of a platinum wire or foil plated with platinum black, which, when saturated with hydrogen gas, functions as a hydrogen electrode. There are two general types. In one the hydrogen is supplied in a continuous stream (bubbling type) and in the other the hydrogen is confined with the solution in a closed vessel, the electrode being alternately exposed to the hydrogen gas and to the sample by shaking the vessel (rocking type). The bubbling type should never be used on water since the stream of hydrogen removes carbon dioxide and changes the pH. While the hydrogen electrode is the primary standard method for pH, so many difficulties are encountered in its use that it is seldom employed except for standardization and fundamental research. However, it should be remembered that all other methods are secondary. In practice when an electrometric method is required, either the quinhydrone or glass electrode is employed.

The quinhydrone electrode is an oxidation-reduction system containing a noble metal (gold or platinum) electrode. In such a system at any temperature the potential depends on the pH and the ratio of oxidant to reductant. Quinhydrone is a compound made up of equimolecular proportions of quinone and hydroquinone. The ratio of oxidant to reductant is fixed and the potential is then a measure of the pH.

The range of the quinhydrone electrode is limited. It functions best in acid solutions. Ordinarily the upper limit of accuracy is about pH 8.0. It is affected by any oxidizing or reducing agent strong enough to change the ratio of oxidant to reductant. Results on samples containing iron, manganese, active chlorine, hypochlorites, sulfites, etc., should be accepted with caution. In the case of slightly buffered solutions above about pH 5.0, the acidic nature of the quinhydrone may result in pH changes when it is placed in the sample. Consequently this electrode is not very satisfactory for waters unless they happen to be well buffered. In waters of low buffer capacity, 5 to 50 parts per million total alkalinity, pH 5.0 to 8.0 quinhydrone may lower the pH as much as 0.3 to 0.5 of a unit.



The Author at Work

A glass surface of the proper composition when in contact with a solution can instantly generate on its surface an electrical potential which is directly proportional to the pH of the solution. The glass electrode requires no hydrogen gas, quinhydrone, or other chemical, only the glass surface, suitable reference electrodes, liquid junction and a voltage measuring device being necessary. However, due to the high resistance of the circuit it is necessary to employ some type of electronic device, (vacuum radio tubes) to amplify the current. This measuring device must be carefully designed to prevent leakage of current and pickup of stray currents or serious errors may result.

Above about pH 9.5 sodium ions may introduce errors. The readings are lower than the true pH and the magnitude depends on the pH, temperature and the concentration of sodium ions. However, it is possible to apply correction factors with good accuracy if the sodium ion concentration is known.

The glass surface has adsorptive tendencies and in changing from one sample to another the electrode must be well washed. It is necessary to standardize the electrode against a buffer solution of known pH. Serious errors may result if a water sample is then tested without efficient washing of the electrode. It is also claimed that the soluble glass used in the preparation of the electrode may effect the pH of unbuffered samples such as distilled water.

The best type of electrode vessel to use in testing water with the glass electrode is one employing continuous flow. This gives complete washing, overcomes glass solubility effects and avoids loss of carbon dioxide during the test.

For reasons of simplicity and economy the colorimetric method of determining pH is being used extensively and it is the main purpose of this article to examine the possible sources of error and to point out ways of increasing the accuracy.

Colorimetric Methods—

The colorimetric procedure in most common use employs color standards in intervals of 0.2 pH. These may be prepared by the worker or purchased from a firm specializing in such equipment. The general procedure is to treat a measured volume of the sample in a test tube of definite diameter with a measured volume of a standardized indicator solution. This mixture is then compared with the color standards and the pH thus determined. The sensitivity of this method is usually about 0.1 pH but in some cases variations of 0.05 pH can be detected by experienced workers.

There are certain sources of error in making pH determinations that will be obvious. It is assumed that measurement of sample and indicator solution will be reasonably accurate, that contamination from unclean glassware, acid or alkaline fumes, alum dust, lime dust, use of the fingers or thumb to seal the tube in mixing, etc., will be avoided. The factors to be discussed are more or less inherent in the method and are not entirely due to faulty manipulation. They will be discussed under (1) color standards (2) indicator solutions (3) salt concentration of the sample, (4) carbon dioxide, (5) temperature and (6) active chlorine.

It is obvious that color standards must remain constant in shade and intensity for reasonable periods of time and they must match the colors produced by the indicator solutions in the test portion. While the writer lacks data on color standards made from artificial media such as glass, etc., solution standards have been made that have maintained the correct colors for over eight years. For all practical purposes such standards can be regarded as permanent.

A common practice is to attribute all inaccuracies to the color standards. Except in cases of obvious failure, other sources of error in determining the pH of water are much more important.

The indicator solutions must give colors that match the color standards both in shade and intensity. In addition they must have the proper pH and this is extremely important in testing unbuffered or very slightly buffered materials such as water.

In determining the pH of buffered solutions reasonable differences between the pH of the sample and the indicator solution will not affect the results. However, in the case of unbuffered solutions the pH of the indicator solution must be fairly close to the pH of the sample or the indicator will change the pH (1). For most routine tests on water the pH of the indicator solution should be at or near its own midpoint, as bromcresol green, pH 4.6, chlorphenol red, pH 6.0, bromthymol blue, pH 6.8, cresol red, pH 8.0, etc. This is why it is impossible to secure consistently accurate results on slightly buffered solutions when a single wide range indicator (universal, utility, etc.) is employed. Errors as high as 3.0 pH units may result (2). This is because the pH of the wide range indicator may vary so widely from that of the sample.

Effect of pH of Indicator Solutions—

The following experiment will demonstrate the effect of the pH of the indicator solution on strongly and weakly buffered solutions. A phosphate buffer, pH 7.8, was diluted with variable amounts of CO_2-free water. Each dilution was tested with three separate phenol red solutions having pH values of 7.0, 7.6 and 8.2 respectively. At dilutions up to and including 1:100, all three indicator solutions gave the same reading, pH 7.8. At 1:1000 the readings were 7.5, 7.7 and 7.8, while at 1:10,000 the readings were 7.2, 7.5 and 7.8.

In spite of the fact that a number of investigations (1, 2, 3, 4, 5, 6) have demonstrated that indicator solutions should be adjusted at or near their respective midpoints when testing slightly buffered solutions, this factor is frequently neglected in testing water. In Standard Methods of Water Analysis (8th edition, 1936, page 73), directions are given for preparing indicator solutions for hydrogen ion tests. The procedures recommended yield solutions of the monosodium salts which will have pH values that are too low for determining the pH of water. For example the probable pH values will be bromcresol purple 5.0, bromthymol blue 5.9, phenol red 6.6 and cresol red 6.6. Such solutions will invariably tend to give low results on waters although they will be satisfactory for determining the pH of well buffered solutions.

The pH should be near the midpoint if a single indicator solution is being used and the theoretical amounts of sodium hydroxide are:

Indicator	Midpoint	Ml. 0.05 N NaOH per 0.1 g.
Bromcresol Purple	6.0	4.9
Chlorphenol Red	6.0	6.3
Bromthymol Blue	6.8	4.8
Phenol Red	7.6	7.7
Cresol Red	8.0	7.1

However, due to the fact that the indicator dyes may contain traces of other acids and the carbon dioxide content of the distilled water used may vary, the final amount of alkali required should be determined by actually measuring the pH of the indicator solutions.

Keeping Indicator Solutions—

Indicator solutions covering the middle portion of the pH scale (pH 3.0-9.0) should be stabilized against the carbon dioxide of the air by aerating to equilibrium at the respective midpoints. They should be kept in resistant glass (Pyrex) containers sealed with rubber stoppers. Soft glass bottles and corks should never be used or marked changes in pH may occur.

Indicator solutions kept in soft glass bottles will show an increase in pH due to the solubility of the glass. Such gross changes as bromphenol blue, pH 3.8 to pH 7.15, bromcresol green, pH 4.6 to pH 6.55, bromthymol blue, pH 6.8 to 7.95 have been noted in this laboratory.

Corks are highly acid and they should never be used to seal bottles containing indicator solutions.

Whenever it becomes necessary to collect, store or transport water samples, the same precautions given for indicator solutions should be observed.

If very accurate pH results are necessary or if distilled water is being tested, the isohydric indicator method of Acree and Fawcett (1) should be employed. In this method several solutions of each indicator are used, adjusted to lowest, midpoint and highest useful pH values or solutions adjusted at 0.2 pH intervals over the useful range. The correct pH is shown by agreement between the pH as read and that of the indicator solution used. The isohydric indicator method must be used in testing distilled water.

The following table contains colorimetric pH readings secured on water samples falling within the pH ranges of bromthymol blue and phenol red. Three solutions of each indicator were used adjusted to different pH values. The pH readings on the waters regarded as most highly accurate are in italics.

Whenever reasonable checks are not secured with several indicators, the variation is usually due to one or more of the indicator solutions being out of pH adjustment. However, readings made by matching against either end standard, in a given set, should be accepted with caution. For example a sample may appear to match the bromthymol blue standard pH 6.0 and actually have a pH value below this. Similarly a sample may appear to match bromthymol blue pH 7.6 and actually have a higher pH.

When readjustment of an indicator solution is necessary, dilute (0.1N) acid or alkali may be added as required. Rough adjustment is possible by comparing the color of the indicator solution in the tip of a pipette with the color standards.

Sample	Bromthymol Blue			Phenol Red		
No.	6.5	7.1	7.6	7.1	7.5	8.0
1	*6.6*	*6.6*	6.7	6.8	6.8	.....
2	7.3	7.4	*7.5*	7.4	*7.5*	7.6
3	.....	7.6	7.6	8.1	8.2	*8.2*
4	.....	7.6	7.6	7.9	*8.0*	*8.0*
5	6.9	*7.1*	7.2	*7.0*	7.1	7.4
6	7.0	*7.2*	7.4	*7.2*	7.3	7.5
7	.....	.....	7.6	8.0	*8.1*	*8.1*
8	.....	.....	7.6	7.8	7.9	*8.0*

More exact adjustment can be made by use of special tubes. Two tubes are used, one fitting inside the other. The indicator solution is placed in the larger tube, which should have the same diameter as the color standards. The smaller tube is filled with distilled water and inserted in the larger tube. The total clearance must be such that the resulting layer of indicator solution matches the color standards in intensity. This layer can then be compared directly with the color standards.

The colorimetric measurement of pH is based on the assumption that if an indicator in two solutions has the same color the pH of both solutions is the same. Actually the color depends to some extent on the concentration and type of salts present as well as on the pH.

Effect of Salt Concentrations

By varying the concentration of a buffer mixture and determining the pH both by a hydrogen electrode and by the colorimetric method, it will be found that absolute agreement occurs only at the concentration of buffer employed in making the colorimetric standards. Above this concentration the colorimetric method will give results that are slightly higher than those secured by the hydrogen electrode. Below this concentration the colorimetric results will be lower. This is illustrated by the data (7) given in the following table:

EFFECT OF VARIATION IN SALT CONCENTRATION

Molar Conc.	Hydrogen Electrode pH	Colorimetric pH	Difference pH Hyd. Elect.—pH Color. (Correction)
0.200	6.33	6.40	—0.07
0.100	6.42	6.45	—0.03
0.050	6.50	6.50	0.00
0.020	6.57	6.55	+0.02
0.010	6.62	6.55	+0.07
0.005	6.68	6.55	+0.13

Absolute agreement occurs only at a molar concentration of 0.05, that employed in making the color standards. These variations are commonly referred to as "salt errors". Most workers know that high salt concentrations introduce errors but the errors due to salt concentrations below that employed in the color standards are frequently ignored.

The concentration of salts in waters is invariably lower than that used in the colorimetric pH standards. Consequently the colorimetric readings tend to be slightly lower than the true pH values. The actual difference will vary from 0.15 to 0.20 pH depending on the salts present and the indicator employed. This is based on the assumption that errors due to incorrect adjustment of the indicator solutions do not cancel salt effects. There is need for further investigation at low salt concentrations.

In general the pH of natural waters is determined by the ratio between total alkalinity and free carbon dioxide. This relationship has been expressed by Tillmann as

$$pH = \log \frac{Alk\,(ppm\ CaCO_3) \times 0.203 \times 10^7}{Free\ CO_2\ (ppm)}$$

The pH of all waters depends to a great extent on the carbonate equilibrium, CO_2-HCO_3-CO_3.

It can readily be seen that any appreciable change in the carbon dioxide content during testing will change the pH and introduce errors. Any manipulation that permits gain or loss in carbon dioxide must be avoided.

There is always a tendency for the sample to strike an equilibrium with the carbon dioxide pressure of the atmosphere. This explains why an N/10 solution of sodium bicarbonate will increase in pH and an N/10 solution of sodium carbonate will decrease in pH on exposure to a normal atmosphere. This also explains why it is practically impossible to secure reliable pH readings on any water with the bubbling type hydrogen electrode. The stream of hydrogen removes carbon dioxide and changes the pH during the measurement. For example a sample of 0.01N sodium bicarbonate showed an initial pH reading of 8.20 with the bubbling type hydrogen electrode but the pH gradually increased until within an hour the reading was pH 8.95 and equilibrium had not yet been reached.

When samples of silt bearing waters were filtered, the pH increased as much as 0.4 due to loss of carbon dioxide during filtration.

Waters of extremely low buffer content may absorb carbon dioxide from the air during the test, resulting in a decrease in pH. This effect is most pronounced in the case of distilled water if it is practically carbon dioxide free.

Distilled Water Normally Acid

Distilled water is devoid of buffer action and special precautions must be observed in testing it. Absolutely pure water has pH 7.0 at 25°C. Ordinary distilled water is usually acid, due to absorption of carbon dioxide. Distilled water in equilibrium with the carbon dioxide of the air will have pH 5.7. And, it may be supersaturated with carbon dioxide to give a pH as low as 5.0 Carbon dioxide may be removed by boiling in Pyrex vessels to produce a water with a pH of 6.6 to 6.8, but super-pure water with pH 7.0 can best be secured by means of a special still. When distilled water of low CO_2 content is required, it should be kept in Pyrex or tinned vessels and contact with the CO_2 of the air held at a minimum. It should be protected with soda-lime or ascarite tubes.

Factors in the pH Determination

In making a pH determination on water the indicator solution should be placed in the test tube and the water being tested run in from a pipette holding the tip of the pipette near the bottom of the tube. Mixing can be accomplished by stirring with the tip of the pipette. Mixing should never be done by placing finger or thumb over the mouth of the tube. Violent shaking should be avoided.

Temperature affects the degree of ionization of salts, acids and bases as well as of water itself. Since the pH of a solution depends on the degree of ionization of its constituents, the influence of temperature on pH is an important factor. Irrespective of the method of measurement em-

ployed, pH determinations should be made at a fixed temperature in order to be comparable. In the majority of cases a temperature of 25°C. is the most satisfactory. With the colorimetric method variations between 20 and 30°C. are usually insignificant for practical purposes. The sulphonephthalein indicators are not influenced by moderate temperature changes to any marked degree but methyl orange and related indicators are very susceptible to such changes.

The action of free chlorine and hypochlorites must be considered in water treatment plants, paper mills, textile mills, etc., whenever the dosage of active chlorine is high enough to affect the indicators. When such action accurs, the results are influenced by the particular indicator in use, the concentration of indicator employed, the temperature, and the concentration of available chlorine.

In general the danger point with the sulphonephthalein indicator dyes is about 2.0 parts per million of active chlorine with the colorimetric equipment in common use. In those rare cases where very low concentrations of indicator are used as in deep tubes the action of chlorine may cause errors at lower concentrations of chlorine.

Two types of reaction occur, direct chlorination and oxidation. In the case of chlorphenol red and phenol red, chlorination appears to predominate at first and the chlorinated dyes which result have lower pH ranges than the original dyes. This results in an increase in the alkaline color which leads to results that are higher than they should be. On longer standing if the concentration of chlorine is high enough, fading will occur due to destructive oxidation. In the case of the other sulphonephthaleins the action is largely destructive and the readings tend to be low or off colors result.

The nitrophenols are more stable in the presence of active chlorine and can sometimes be used when the concentration of chlorine is as high as 200 parts per million (8). However, the nitrophenols are all fairly acidic and their solutions are difficult to stabilize at any definite pH. In addition they lack pronounced color changes, these being from colorless to yellow.

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N. J. Association Planning Silver Anniversary Convention

High-Spot in History of America's Oldest Sewage Works Association

On October 6th, the "Go Ahead!" was given by officers of the New Jersey Sewage Works Association to a special committee of wheelhorse members, and a few drafted friends of experience in such things, to put on a real show in celebration of the Silver Anniversary of this oldest of America's Sewage Works Associations — organized 25 years ago to unravel such mysteries as why American Imhoff tanks persisted in working "upside down".

At the time of its founding a young assistant sanitary engineer, then with the N. J. State Department of Health, left his position and security to become a pioneer in another direction—that of putting into successful usage the application of liquid chlorine in the sanitary field. How successfully he flirted with the "Green Goddess", at the throne of which Messrs. Wallace & Tiernan worshiped long and tireless hours in those early days, is now a matter of record. And, the march of sanitation and public health has brought us far during the two decades and a half of chlorination history and that of America's pioneering organization of sewage works managers and members of the sanitary engineering profession. (In those early days before the mid-west grew sewage minded there were trecks half way across continent by engineers wishing to glean sewage disposal knowledge within the meetings of the New Jersey Association.)

Bill Orchard Drafted

It seemed both fitting and fortunate, then, that the Executive Committee of New Jersey's Association should and could draft Wm. J. Orchard, that one time young New Jersey sanitary engineer and courter of the "Green Goddess", to take charge of plans and production of its Silver Anniversary Convention and Celebration. But, with the reputation gained through similar productions in A.W.W.A. who, other than "Bill" Orchard, could have been picked to do it better?

With the "Go Ahead!" given on October 6th and the dates set for March 20, 21 and 22, 1940—the Executive Committee put arrangements for the Anniversary Convention in the hands of "Bill" Orchard, as Chairman of its Steering Committee; named Dr. Lynn J. Mahaffey, Director of Health of N. J., as Honorary Chairman; H. P. Croft as Vice-Chairman and the following as members:

John R. Downes, P. N. Daniels, Linn H. Enslow, Edw. P. Molitor, Paul Molitor, Jr., Samuel Probasco, Erw. F. Shissler.

Three other experienced drafters, chosen to put the wheels in motion and keep them turning toward the goal set—namely, the largest and most successful convention of N. J. S.W.A., are the following:

Chas. H. Becker, Chairman (Committee on Exhibits); Anthony J. Anable, Vice-Chairman (Committee on Publicity and Attendance); Joe Wafer, Vice-Chairman (Committee on Arrangements and Entertainment).

The reputation of all three is well established and all we can add at this writing is to say that N. J. S.W.A.'s Silver Anniversary Celebration should be the biggest sewage works show ever staged, here or abroad. It will have National if not International savor and like the days of yesterday, North, East, South and West will probably meet again on Jersey soil, where the battles between Imhoff Tank Designers and Imhoff Tank Operators raged from year to year.

It has even been hinted that Dr. Imhoff himself may be influenced to come over for the "great reawakening" on March 20-22.

Rest assured that the technical program will have on it names of National or International consequence. There will be a special effort made to develop papers by operators for operators, with time for "cussing and discussing".

Trenton's War Memorial Building has been secured for Manufacturers' Exhibits and Meetings. The Hotel Stacy-Trent, directly across the street, is the headquarters hotel.

Permutit Spaulding Precipitator

New Cold Lime Treatment Makes Good!

Spaulding Precipitator installations are breaking records . . . more than 20 plants within the last few months . . . ranging in capacity from 5,000 to 8,000,000 gallons per day! Two features: **1.** *Sludge is kept suspended*—this speeds precipitation, also acts as a contact filter. **2.** *Conical filter-chamber*—this lowers velocity as water rises. Sludge drops out, leaves effluent clear, sparkling.

NOW GET SOFT, IRON-FREE WATER . . . ECONOMICALLY!

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Less chemicals are needed, for one thing. For another, water is so stable that recarbonation is often unnecessary. Here's something it will pay you to investigate immediately!

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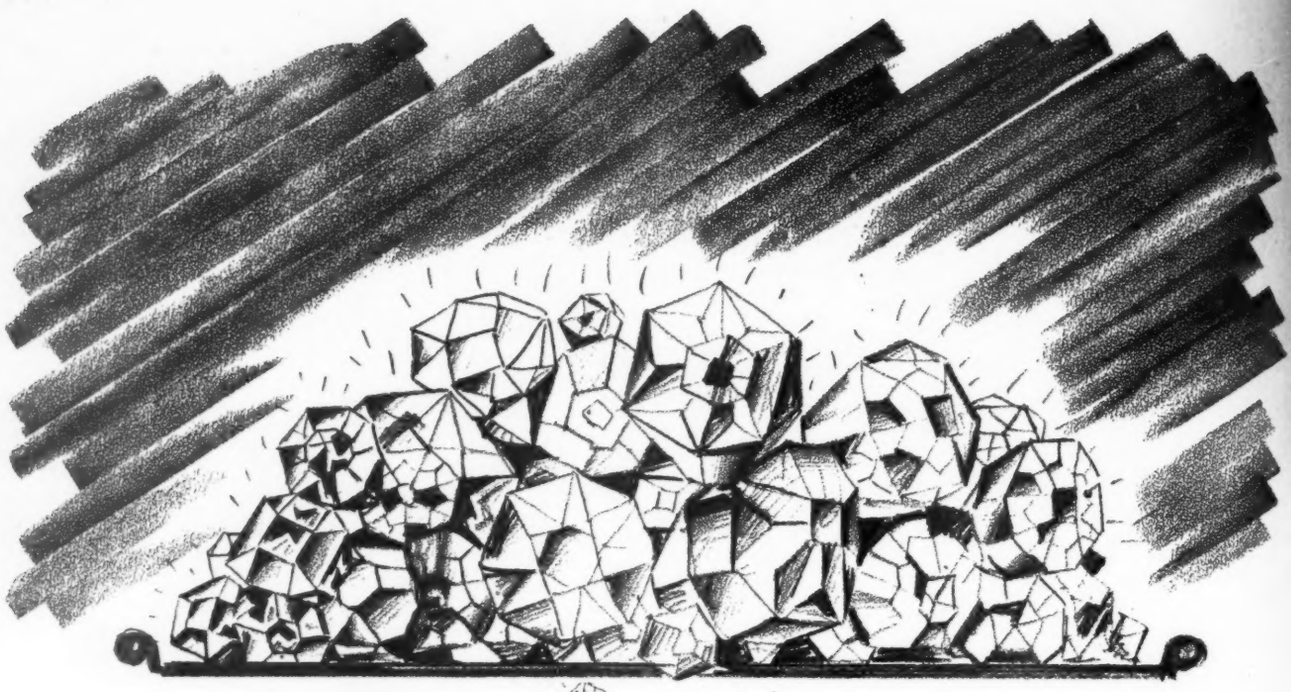
WATER CONDITIONING *Headquarters*



"Diamonds"

AT A FEW CENTS A POUND

The diamond in an engagement ring, the charcoal used to broil a steak and the graphite in a pencil are all carbon, which scientists call the "wonder element" of nature. Carbon is the chameleon of the elements and these three common forms have long been the subject of scientific study.

A few years ago a fourth type of carbon was discovered which has properties considerably different from other types of carbon. This new form of the element is known as Activated Carbon, so named because it has purifying powers nearly a hundred-fold greater than those of ordinary charcoal.

A pound of carbon in the form of diamonds is worth many thousands of dollars, while a pound of Activated Carbon costs but a few cents. However, a pound of diamonds placed in a waterworks would be of no value in improving the quality of the water. But a few pounds of Activated Carbon ordinarily removes the disflavors from 100,000 gallons of water.

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NUCHAR — AQUA NUCHAR

J.E.GIBSON *writes:*

LONG LIFE

At right is an unretouched photograph of a cast iron water main now in its 109th year of continuous service to the citizens of St. Louis. Taxpayers are saved millions of dollars every year by the continued service of cast iron pipe long after the construction bonds have been retired and forgotten.

SALVAGE VALUE

Photo at left shows a 42-inch cast iron water main being relocated at Cleveland, Ohio, after 46 years of satisfactory service. Salvage value is but one of the tax-saving features of cast iron pipe.

Water mains represent about one-third of this country's 5-billion-dollar investment in public water supply systems. More than 98% of these mains are cast iron pipe with a *known* useful life at least double the *estimated* life of other water main materials. Because the tax-saving, through deferred replacements alone, is enormous, cast iron pipe is known as Public Tax Saver No. 1.

CAST Q IRON

Look for the "Q-Check" Registered trade mark. Cast iron pipe is made in diameters from 1¼ to 84 inches.

LOW MAINTENANCE

is an economy feature of cast iron pipe that is not confined to Charleston. An impartial survey among 195 waterworks superintendents shows that the maintenance cost of cast iron pipe is *far below* that of any other pipe material which has been in use long enough for the recording of conclusive data.

KOPPERS DAMPPROOFING USED TO COAT SEWAGE PIPE—This photograph shows concrete sewage pipe coated with Koppers Dampproofing materials inside and out. The coatings inside protect the concrete from the action of the sewage. The exterior coatings protect the concrete from the disintegrating action of ground waters. Koppers Dampproofing Materials, made of coal tar pitches, are best for this type of work because of the high degree of water-resistance they possess.

KOPPERS POWER SURVEY SAVES ONE PLANT $65,000—Additional power was needed in one plant and tentative figures indicated the need for two more boiler installations totalling around $150,000.00. The Engineering and Construction Division of Koppers was asked to make a power survey before this expenditure was made. Koppers engineers recommended methods of conserving steam which enabled the plant to get all the additional power with one new boiler costing about $85,000.00. Koppers will be glad to consult with you on any problem involving steam or electric power installations.

PRESSURE-TREATED PILING GIVES LONG LIFE AT HALF COST OF OTHER MATERIALS—Pressure-creosoted timber piling, for building foundations and for waterfront work, averages approximately half the cost of other permanent types of piling in place. It has demonstrated its long life and serviceability. The Wood Preserving Corporation, a Koppers Company subsidiary, will be glad to work with you on the selection of the proper piling.

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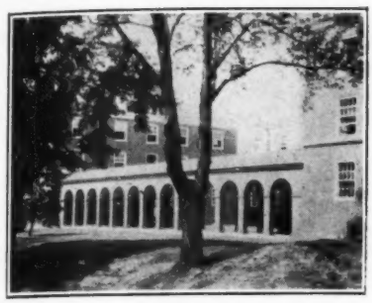
VIRGINIA SECTION MEETS AT UNIVERSITY OF VIRGINIA

Success of Scheme Brought Vote to Repeat in 1940

Reported by ROLAND J. LEVEQUE
Supt. of Filtration
FREDERICKSBURG, VIRGINIA



Davis Hall
The University's Swankiest of Dorms. Ours for the Meeting.

"Collegiate, collegiate—
Yes we are collegiate!"

—might well have been the theme song of the Virginia Section this year. They went to college, so to speak—and speak they did on topics covering a variety of well chosen subjects which are of interest to the waterworks profession. The classroom atmosphere which seemed to prevail, lack of distractions, and the well attended sessions marked the meeting throughout. The famed campus of Virginia's University supplied an atmosphere conducive to all of this.

However, one must not gather from the above that these sessions were in any sense stiff or formal. Some of the "professors" eased the tension of their listeners with well timed bits of extemporaneous humor, while others incorporated into their papers a few laugh provokers ranging from the poetic to the dramatic, and a feature on the program was a three-act skit—both human and humorous. (Personally, we think they've got something there. The injection of a bit of humor into a technical program seems to provide a relief similar to that experienced in that good old seventh inning stretch at the baseball game, or the smoke between acts.)

Selection of the University by the committee was more or less of an experiment, it being felt that the usefulness of the Virginia Section in providing more instructive and beneficial meetings could be better realized in these favorable surroundings. The low cost for accommodations in the university dormitories and the fraternal spirit created also had its appeal, especially to those men from the smaller towns which very often do not include in their budgets appropriations which will enable waterworks personnel to attend these annual meetings. The large percentage of these men attending this year gave every indication that the committee did not err in this respect.

Chairmen

Howard A. Johnson (Retiring) Danville, Va.

Wm. G. Myers (Incoming) Harrisonburg, Va.

Entertainment Not a Feature

While nothing in the way of special entertainment was provided, the committee did not lose sight of the fact that the way to a man's heart is via his stomach. An excellent picnic supper consisting of fried chicken, Brunswick stew and all the doo-dads that go with these delicacies was served and enjoyed on the wooded grounds adjoining Fry's Springs Studio. A large pool was available to all who cared to take a cooling plunge. (From a strictly Kibitzer standpoint, it must be confessed that after looking over our crop of waterworks "Mermen"—our vote still goes to Eleanor Holm and her Mermaids.)

After supper an interesting movie was shown in the studio hall through the courtesy of Industrial Chemical Sales Corporation. This was followed by an announcement of the winners in the round of golf held that morning. When the swings made in the rough (killing snakes) were subtracted from the scores it was found that *D. R. Taylor* of Roanoke was the "winnah" of first prize and Neptune Meter's *Mike Siebert,* from Richmond, captured the second trophy.

Marsden Smith Voted Fuller Award

Following this, the citation naming *Marsden C. Smith,* Chief Engineer, Dept. of Public Utilities, Richmond, as the member most deserving of the Geo. W. Fuller Award, was read by *R. C. Bardwell,* Chairman of the Award Committee. Mr. Smith was named "for his engineering ability, initiative, research and development, management, and his inspiring leadership in the section."

Mr. Harry E. Jordan, Executive Secretary of A. W. W. A., was then introduced as the principal speaker by *Gene Dugger,* Mgr. Newport News Waterworks, and a Past President of A. W. W. A.

Mr. Jordan gave an inspiring and timely address, an account of which appears elsewhere in this report.

The conclusion of his address rang down the curtain on the official activities of the opening day. And so to bed—oh yeah!

Officers Elected

The following were elected officers for the ensuing year:

Chairman—Wm. G. Myers, City Engineer, Harrisonburg.

Vice-Chairman—R. W. Fitzgerald, Chief Chemist, Norfolk.

Secretary—E. W. Snidow, Va. Dept. of Health, Richmond.

Treasurer—E. C. Meredith, Va. Dept. of Health, Richmond.

Executive Committee — Marsden C. Smith (Richmond), H. A. Johnson (Danville), H. W. Hayes (Lawrenceville).

Technical Sessions

Chairman, *H. A. Johnson* opened the sessions with a brief address of welcome and then introduced the first speaker, ROLAND J. LEVEQUE, Supt. of Filtration, Fredericksburg, Va.

Mr. Leveque's paper constituted a brief outlining of the recently completed enlargement program which increased the capacity of the Fredericksburg plant from 2.0 M.G.D. to 6.0 M.G.D. He then recounted the results obtained from what he considered the three outstanding improvements.

(1) Mechanical Slow Mixers

Mr. Leveque stated that the gentle stirring action of paddles in the new mixing and flocculating tanks resulted in an unmistakable improvement in floc formation. He emphasized the desirability of installing any device which brought about an improvement, but if it would effect economies as well, its adoption practically became a necessity.

By means of a record chart, the savings in chemicals over a five-month period at Fredericksburg were revealed. Alum and lime dosages had been reduced 21% and 49.2% respectively. This represented a saving of 9.9 tons of alum and 6.2 tons of lime.

He felt confident that when further records could be tabulated on wash-water and other items, additional savings would be shown.

(2) Adjustable Weir Plates

He then cited the advantages of adjustable weir plates which had been installed in the collecting troughs supplying the filters. Raising or lowering these to proper levels permitted an equalized draft from all basins, eliminating cross-currents and dead areas. Since the head coming over these is maintained at approximately ¼ of an inch, only the uppermost portion of the settled water reaches the filters.

(3) Enslow Stability Indicator

The practicability of this device, first proposed by *L. H. Enslow* at the meeting of the Virginia Section a year ago, appealed to the speaker. In setting the device up for operation he encountered difficulties in passing water up through the chalk powder, which formed a thick sludge when wetted. To overcome this, he filled the primary tube (originally glass but now copper) with successive two-inch layers of marble chips and powdered chalk, carrying this charge up to within four inches of the top of the tube. Two inches of torpedo sand was then added with a plug of glass wool to prevent washing of the sand over into the other tube. Checks on this device using the Baylis Marble Test showed that the apparatus was providing sufficient contact, thereby giving the correct "Enslow Index" of the corrosivity of the treated water passing through the apparatus.

Stalwarts

Richard Messer, Virginia's Chief Engineer of Health [Turned his going Water and Sewage Wks. Assoc. over to A.W.W.A. 6 years ago]. Marsden Smith, Chief Engr. Dept. of Utilities, Richmond [Virginia's "White-Horse," so recognized by being voted the George W. Fuller Award for "Inspiring leadership in the Section and ability as a water works engineer."] Harry E. Jordan, Exec. Secy. of A.W.W.A. [He liked the meeting, and the honoring of a highly valuable member and Director of A.W.W.A.]

Officers

R. W. Fitzgerald Norfolk's Chief Chemist (New Vice-Chairman)

H. W. Hayes, Supt., Lawrenceville, Va. (Elected to Executive Board)

Mr. Leveque felt that of the methods advanced thus far to determine calcium carbonate stability, this simple device furnished the most rapid and practical means for checking the equilibrium of a finished water. He concluded his paper with a bit of "Rocking Chair" poetry dedicated to Enslow's "Convention Chair" invention.

Replying to queries by *Marsden Smith* (Richmond) as to whether a check had been made in the mains for after-precipitation, Mr. Leveque stated that his preliminary studies had been concentrated on getting the indicator to function properly, and that no check on the mains had been made.

Richard Wagner (Lynchburg), then asked at what pH equilibrium was established in the Fredericksburg water, Mr. Leveque replying that a pH of 9.0 with an alkalinity of 36 P.P.M.

"Experience Hour"

In introducing the next feature of the program which had been cleverly titled "Why I Do What I Do . . ." (by anyone who will) and "What Should I Do About . . ." (by anyone who wants to know), *Chairman Johnson* cited criticisms of former programs in which too much time was consumed on specific papers which concerned only a few. It was felt that allotment of a period for open questions and discussions of general problems would provide an opportunity for all to use this means of imparting and receiving information. It can be truthfully said that this turned out to be a real "Jam Session".

D. R. Taylor, Supt., Roanoke Water Department, was asked to start the ball rolling. In response, he cited the advantages of aluminum paint as a priming coat with subsequent use of red lead, asphalt or deck paint in painting metal tanks and wooden structures. At Roanoke this method had proved more effective than any other scheme heretofore used in protecting the surfaces of these structures.

He next told of using sectional maps of the distribution system made on 100-foot scales. These were marked with a circle around each block and contained such pertinent data as would facilitate the spotting of valves in the event of leaks. Also the age of each main is indicated. When pieced together these sections formed a complete map of the entire distribution system.

Water Hammer Correction

Marsden C. Smith cited the dangers of water hammer by failure of electric pumps due to sudden power lapses. At Richmond, a line 6700 feet long in which the static elevation difference was 155 feet, the rise being in the first 1500 feet, caused the water column to separate at the apex of the line which was 27 feet above the hydraulic gradient. On this 36-inch line apex, two 2½-inch combination air intake and release valves were installed. The air sucked into the pipe at the instant of vacuum provided sufficient of an air

cushion to absorb the return shock. Tests up to 26 M.G. were made without any hammer or check slam being detected.

Richard Wagner (Lynchburg) narrated experiences and difficulties in laying pipe under a swiftly moving stream when cribs of too great length were used to float the pipe out into place. These were broken by the swiftly moving current, but when cribs were built in 15-foot sections no further trouble was encountered.

E. R. Sharp, Assistant County Engineer, Henrico County, Richmond, asked how pressures could be maintained in lines when two tanks which needed painting had to be removed from service. In reply, D. R. Taylor, suggested putting a pressure gauge on the line and employing valve throttling at the pumps with a man on constant watch, to maintain pressure up to normal. Bleeding fire hydrants would also prove helpful to hold down pressures.

Tank Protection

R. C. Bardwell, Superintendent of Water Supply, C. & O. Ry., Richmond, said that the C. & O. Railroad had 137 tanks of various sizes to maintain and that tests conducted using modern paints advocated by eight leading manufacturers, showed that the majority failed to afford the necessary protection against corrosion. Of the paints used, he found the bituminous coatings superior to more costly products.

As a result of these experiences four tanks had been recently equipped with single electric devices providing cathodic protection. These units are cheaper than paint, but had not been in use on C. & O. tanks long enough to make any predictions. Mr. Bardwell stated, however, that from what he had seen he believed these cathodic units to be the solution of internal tank corrosion problems.

M. C. Smith told of conditions prevailing in the poorer sections of Richmond which are entirely devoid of inside plumbing, the only source of water being yard hydrants. The anti-freeze drip hole which permits the water to leak into the soil creates a soggy mire. This promoted the growth of worms, which at times worked back up into the hydrant. Mr. Smith asked what could be done to remedy this situation.

Richard Messer, Director of Sanitary Engineering, Va. State Dept. of Health, stated that in his opinion it was the responsibility of the manufacturers to construct a hydrant into which worms could not gain access.

In the discussions which followed, various suggestions were advanced. Legislating against this type of hydrant, insulating it in rock wool to prevent freezing, eliminating the underground drip, or encasing it in 36-inch tile were a few of the remedies proposed. The problem of this potential menace to health and public relations still remains however.

Past-Presidents

E. F. Dugger, Manager, Water Dept., Newport News [Also past-president of A.W.W.A.] A. L. Meisel, Town Mgr. Williamsburg. D. R. Taylor, Superintendent, Roanoke [Under his administration the Section's most outstanding meeting—a "Little Convention" it was dubbed].

At this point *R. C. Bardwell* asked if he might say a few words on the use of "Calgon", which in his opinion was a wonderful chemical. He reported good results in its use by the C. & O. Ry. over a period of three years. Dosages varying from 1 pound in 20,000 gallons to 1 pound in 60,000 gallons had been successful in stopping hot line scale formation and arresting corrosion in their lines. He commented that this water was for boiler purposes but that the safety of this chemical used in a drinking water was vouched for by the Ohio State Board of Health.

Committee Heads

R. Stuart Royer, Cons. Engineer, Richmond. Richard F. Wagner, Director Public Wks., Lynchburg. Robert C. Bardwell, Supt. of Water Supply, C. & O. Ry. System, Richmond.

"The Hardest Nut"

The next paper on the program "Public Relations" by *D. R. Taylor,* Plant Superintendent, Roanoke, was presented in the form of a humorous three-act skit which bore the title, "The Hardest Nut Can Always Be Cracked"—if you use the right cracker, we might add. Dramatis Personæ of the Mighty Taylor Art Players consisted of the following:

Outraged Consumer.....
J. P. Millikin, Chemist, Roanoke Water Dept.

Manager of Water Dept.....
D. R. Taylor, Plant Supt. Roanoke

Service Man.....
H. E. Lordley, Plant Supt., Richmond

The Girl in the Front Office.....
Miss Camila Hadon (a lot of guys want her address)

SCENE: Any water department office after a hectic day.

TIME: Always just about closing time.

Inasmuch as the entire script of this play will be published in a subsequent issue of this magazine, it will not be reviewed in detail here. Suffice it to say the plot concerns a consumer who has worked up a good "Mad" at the water department over what he deems an outrageous overcharge on his water bill. As the play progresses we see "Doc" Taylor gradually smoothing the volcanic customer's rumpled tailfeathers by means of soft answers, which verily turneth away wrath and his "Tell Tale" recording Device—the Meter Master, or something like it. (When Doc puts his gadget on your water meter he can tell how much water you used to brush your teeth with and, confidentially, he can even tell if you've been running around nights.) To make a long story short, the play ends happily with a most touching scene where we find the ex-outraged customer inviting "Doc" to join him on a week-end fishing trip. [That guy Doc's a master-salesman in disguise.]

Needless to say the playlet was thoroughly enjoyed. It provided some pretty scenery and its share of good laughs, and yet it revealed a workable technique that can be applied in handling consumer complaints.

Mr. Jordan's Address

Mr. Jordan, in his opening remarks, stressed that this would not be a speech, but rather a simple chat in which he hoped he would be able to present a true picture of the association's aims and purposes. He commended the Virginia Section on their selection of Marsden Smith to receive the Fuller Award.

Elaborating on this, Mr. Jordan commented on the influence of ritual in the daily lives of men. Be-

In and Out of the Meeting Room

(1) Waiting for class to be called; (2) Just a little argument about "Calgon" between M. C. Smith and L. R. Caplan (Philadelphia), while Howard Pardee finds it an amusing show; (3) In his skit (Scene II), playwright "Doc" Taylor (a foxy water works manager) flashes on Mr. I. Rate Customer the disarming recording meter chart which turned "The Toughest Nut to Crack" into a "believer" and, later, into a fishing buddy—and that's Public Relations as it's done in Roanoke; (4) "Dic" Kirchner (Mueller Co.) has a couple of good listeners between sessions, but he was sore cause he could take 'em up to his hotel room 2 miles downtown; (5) The Section's handsomest member ("Dick" Wagner of Lynchburg) and Charlottesville's City Engr. (S. L. Williamson) oblivious to the camera.

stowal of the Fuller Award with its citation was in a sense a ritual, impressive and worthy. The practice of striving to merit this award was effective in promoting organization work.

Commenting on the organization's growth, he disclosed that at the present time there were 24 Sections, with a 25th potential Section in Cuba. The willingness and loyalty of the Cuban members are important factors which might influence their acceptance into the organization. Mr. Jordan attributed the success and growth of the organization to the sectional work being carried on. The small operators with their varied problems were being afforded increasing attention and these were being urged to join the association.

Reviewing the work accomplished in the association, Mr. Jordan cited the early efforts of George W. Fuller to standardize laboratory methods. As a result of this work we now have laboratory control methods of which we can well be proud. The use of these methods and the diligence of the operators had resulted in a marked decline in deaths due to typhoid.

Mr. Jordan then told of the work done by the Special Committees, citing their efforts to have steel pipe specifications standardized so that basic selections could be made. (In this respect he made it clear that the A.W.W.A. meant business.) He called attention to the tremendous amount of research that had been made on cast iron pipe in order to make it possible to buy under a standard specification basis. Such work, he said, called for the cooperation of the consumers and producers in the exchanging of ideas. He cited Marsden Smith's work in the field of research as a member of such a committee.

Mr. Jordan stated that he could not conclude his address without calling attention to the possible effect of the War in Europe on prices of waterworks materials. Despite the fact that our relations in this conflict have thus far been indirect, the war tended to stimulate and in a great many instances, basis price levels were on the up-grade. Urging all those in charge of waterworks to satisfy themselves that present supplies of materials are adequate, Mr. Jordan also asked that they bear in mind the possibility of being called upon to extend present services to industrial centers which naturally would increase the need for these materials, hence every precaution should be taken against being caught short of such materials on a rising market, if these expansions became necessary.

To stress the important part played by waterworks men in a democracy, Mr. Jordan quoted a line from John Anderson's play, "Washington at Valley Forge". "This liberty will seem easy bye and bye, when nobody dies to get it." Mr. Jordan said, "We must not regard liberty as a raiment, but as a part of life". He exhorted all watermen to maintain this liberty and this morale, to preserve intact those ideals from the top down to the bottom. If we continued to do our work well we would be exemplifying America . . . anything less than this would be tantamount to sabotage.

Technical Sessions (Friday)

A. T. Lundberg, Chief Engineer, Arlington County Water Dept., introduced a topic of growing importance to waterworks managers, namely, methods of keeping contaminated water from entering the distribution system. Commenting on this, Mr. Lundberg stated that a survey of the average waterworks showed that their records on water in the distribution system were not as complete as their records on plant operation.

In view of recent court rulings holding water departments liable for the quality of the water being delivered at the consumer's tap, he commented on the growing necessity of eliminating anything in the distribution system which might be considered a source of contamination. Enumerating some of these, Mr. Lundberg gave the following as potential hazards.

1. Improper sterilization of new mains.

2. Inadequate flushing of dead-ends and Fire Hydrants.

3. Connections to an outside independent water supply not controlled.

4. Cross-connections which allowed back siphonage under certain conditions.

Describing the Arlington Water Supply, Mr. Lundberg stated that the water was purchased from the District of Columbia and resold by

(1) "Gene" Dugger (that's enough) and Golf Chairman "Mike" Seibert (Richmond) who work for Neptune; (2) From Orange, Va., came Plant Sup't. W. E. Knighton, his boss Richard L. Blankenship, Town Manager, and the boss' boss Mayor H. C. Lonergan. (That's real Town Management when the Mayor is persuaded to attend water works meetings.); (3) Monroe Hall—Headquarters and meeting place; (4) H. W. Hayes (Lawrenceville), Eddie Ruehl—a former "super" (now working with League of Va. Municipalities as field-man) and W. F. Cooke, Town Manager, Manassas, Va.

the Arlington County Water Dept. Samples taken by the U. S. Public Health Service from a dead-end supply at the airport, revealed the presence of an intermediate organism which indicated fecal or non-fecal pollution.

Immediate sterilization of this dead-end was undertaken and calcium hypochlorite solutions of strengths varying from 5000 to 15,000 p.p.m. were injected into the line until a definite residual was obtained at the end of the line. Samples taken after this treatment showed no further contamination by the organisms.

As a result of this experience, *Mr. Lundberg* stated that a definite sampling program had been inaugurated and that twenty sampling stations had been established covering the entire distribution system. Replies to a questionaire sent out by *Mr. Lundberg* revealed a surprising number of cities and towns not carrying out systematic sampling procedure as part of their routine bacterial check-up. He asked that this method of keeping check on the distribution system be given careful consideration. He stated that he saw no reason why uniform report forms could not be used, copies of which would be furnished the State Board of Health in order that they might have a complete record of water conditions in distribution systems throughout the state. He advocated the maintaining of a portable auxiliary chlorinator as part of standard equipment for emergency uses.

Replying to a question as to whether the source of contamination had been ascertained, *Mr. Lundberg* said that it came from a cross-connection on a well supply which was presumed to be cut off by a valve.

Questions by *Mr. Enslow* and *Mr. Smith* as to whether periodic flushing had taken place or tests for chlorine residuals had been made brought replies in the negative.

Mr. Bardwell cited the possibilities of contamination by new pipes, recounting instances wherein as many as three cases of H.T.H. had to be applied to a pipe before it yielded a satisfactory water.

Mr. Jordan substantiated the statement of *Mr. Bardwell,* calling attention to the published report on the technique for sterilizing new mains, these studies being still in progress with much work yet to be done. He revealed how in some instances the utmost precautions failed to check contamination. He said that the finding of Aerogenes, a rotting organism of destruction, did not necessarily indicate a cross-connection.

He commended *Mr. Lundberg,* not alone for what he had done, but for showing what had not been done with respect to keeping water good in the distribution system.

"Corrosion—Its Cost and Cure"

R. L. Blankenship, Town Manager, Orange, discussed the corrosion problem in a small town system, frankly admitting that he was more familiar with its cost than its cure. His paper, however, revealed what a busy Town Manager can do when he takes a mind to.

The acuteness of the situation was discovered when a pipe installed for but little more than a year had to be removed for re-alignment. Inspection showed it to be badly corroded.

Enlisting the aid of the State Dept. of Health, a study was made resulting in recommendations that corrective treatment, which included the use of lime for pH correction and the purchasing of additional laboratory equipment for making control tests, be installed. A battery of ¼-inch pipes consisting of the following materials: black iron, galvanized iron, brass, copper and glass tubing, was mounted on a panel in the Town Manager's office to enable observation of the actual aggressiveness of the water at all times. These pipes are checked at monthly intervals and while the attack on the black-iron pipe continues, it is not so pronounced as it was prior to corrective treatment.

Mr. Blankenship stated that they were very much interested in the Enslow Calcium Carbonate Stability Indicator, the materials for construction of one having been assembled and which they hoped to have in operation soon.

He also told of plans for plant improvements to include Mechanical Mixing. *Mr. Blankenship* stressed that the cost of these corrective measures were justified if they afforded nothing more than just peace of mind.

Mr. H. M. Laudemann, Chief Chemist, C. & O. Ry., Huntington, W. Va., told *Mr. Blankenship* that if he would add "Calgon" in the ratio of 1 pound to 50,000 gallons he might get considerable relief from corrosion. At this point, *Mr. Bardwell* stated that he thought this was an appropriate time to further discuss the merits of sodium hexa metaphosphate in controlling corrosion. He suggested that *Mr. L. H. Caplan,* Sales Engr., Calgon, Inc., be allowed to tell of the work being done with this chemical.

Mr. Caplan cited the experimental set-up at Atlantic City and reviewed the favorable results which had been obtained by users of this chemical. He called attention to the plant scale applications recently introduced in the direction of corrosion abatement, stating that the results of these experiments would be published when completed.

[In the report of the N.E.W.W.A. Convention elsewhere in this issue appears a further discussion of the merits of hexa-metaphosphate, anti-corrosion treatment.—ED.]

The State Dept. of Health and Water Supply

Richard Messer, Director Sanitary Engineering, Va. State Dept. of Health, related some of the history and functions of the Va. State Dept. of Health. Public health was accepted as an essential part of government by Virginia in the year 1782. It was not until 1908, however, that a full time Health Department was put into operation. At that time only seven supplies in Virginia were filtered. In 1939 the supplies now being filtered number eighty-eight.

In 1918 a law was enacted giving

(1) C. A. Johnson, Supt. of Water & Sewage, and J. M. Sample, Filter Operator, Salem, Va.; (2) "Smoke" Clements, W. & T. Co., Washington, D. C. and L. R. Caplan, Sales Engr., "Calgon, Inc., Philadelphia; (3) Alan A. Wood, of Builders' Iron Foundry, Philadelphia, and John L. Atwell, of A. P. Smith Mfg. Co., East Orange, N. J.; (4) Norman Phillips, Jr., Asst. Engr., Va. State Dept. of Health and W. R. Odor, Sales Mgr., Lynchburg Foundry Co., Lynchburg; Jerry Kavanagh, W. & T. Co., Roanoke, Va., and W. McLain Bingley, Sales Engr., The Dorr Co., Richmond.

the Board of Health jurisdiction over all water supplies in the state. An important function of the department being the supervision of plant operations, also acting in an advisory capacity to cities and towns contemplating waterworks construction. In this, he said the department had neither the desire nor the intention to encroach on private consulting engineers, the department's attitude always being one of cooperation. He stated that their records were always available for study by these consultants and he cited the value of such accumulated data in rectifying errors which had shown up in existing plant experiences.

Commenting on the progress which had been made in Virginia, Mr. Messer stated that no outbreak of typhoid had occurred in the state since 1925.

"Storage Reservoirs and Their Effect on Water Quality" by HOWARD A. JOHNSON, Supt. of Filtration, Danville.

Mr. Johnson's paper was essentially a review of current practices in preventing contamination of water stored in open reservoirs.

In treating the two reservoirs of this type supplying the city of Danville, for secondary bacterial growths, he stated that these had been effectively controlled during the summer months by frequent dosages of H.T.H. and Perchloron in concentrations averaging 0.8 parts per million, this being applied in burlap bags which are dragged across the reservoir in 10 feet lanes.

He cited the profuse growth of algæ in the reservoirs which followed the use of ammonia. This he attributed to the uncombined ammonia furnishing a source of nourishment for these growths. Reduction of the ammonia and an increase in chlorine to form a 1 to 5 ratio was responsible for a marked decrease in these growths. (This seems to bear out the work of Griffin in which he found that the true chloramines were in many instances formed at higher ratios of chlorine to ammonia and in some cases as high as 1:16.) Such algæ growths as do form are treated with copper sulphate.

Mr. Johnson spoke of the appearance in reservoirs of the red larvæ of the midge fly as being a dreaded source of trouble inasmuch as they seemed to be beyond immediate control. He stated that he knew of no effective method of killing these worms and to rid his reservoirs of them called for draining and cleaning, a costly procedure in his case.

In his opinion the open reservoir constitutes a glowing case of obsolete operating practice in which the desirable features are greatly overbalanced by the undesirable.

(1) Secretary and Treasurer—H. W. Snidow and E. C. Meredith, Engineers of the State Dept. of Health; (2) Incredulous about something, "Dick" Ford is really being "sold" by "Doc" Taylor; (3) "A Reunion" might be the caption of this picture of "Bob" Haywood of Industrial Chemical Sales with "Fred" Stuart, who still thinks "Nuchar" and uses it in his "Black Alum."

"Sodium Silicates as an Aid to Coagulation" by H. E. LORDLEY, Plant Supt. and M. C. SMITH, Chief Engineer, Public Utilities, Richmond.

This, a most interesting and timely paper, presented carefully compiled data and figures representing a year of study and experimental work with Sodium Silicates. While the results at Richmond disagree in some respects with those obtained by Baylis, Mr. Smith emphasized that the results of their own experiments were in no way a criticism of Mr. Baylis' efforts. He stated that Mr. Baylis was due much credit for his work with this material and that this paper was merely a report of the studies and facts developed by them in an effort to determine the value of the use of silicates at the Richmond plant. It was also hoped that these studies would add to the knowledge of the subject so ably presented by Mr. Baylis.

Dormatory Study

Left to right—Marsden Smith, Dick Ford, Harry Jordan and Norman Phillips. And, (in the corner) the Honorable Treasurer of the Section, with a jammed camera—(will he be surprised). Just look at Harry Jordan in deep study after his partner, who wrote the book "What I Know About Bridge," has raised Harry's bid to 5 spades. To hear the end, would be to weep.

The James River, which supplies the Richmond plant, has such a variation in quality that it created an ideal subject for this study.

The authors concurred with Mr. Baylis in that adjustment of the alkalinity of the silicate solution was of greatest importance and apparently 1200 is the optimum value. Many supplies of lump or powdered sodium silicate were used, of which only one was found to be readily soluble in water. Three other supplies, all in the liquid state, when treated with sulphuric acid developed efficiencies suitable for carrying out the tests.

At Richmond, it was found that silicates aid coagulation at very low turbidities or temperatures; but that after a slight increase in either of these, the benefit becomes negligible. Except at low temperatures or turbidities, the floc produced where silicates are added appeared to be much less adsorptive and the settled water less suitable for filtration.

Tests conducted where silicates were used with iron salts gave results which appeared definitely detrimental to coagulation. Where difficulties are experienced with low temperatures or turbidities, iron salts appear to be much preferred to alum with silicates. However, where adequate settling time is not available and mechanical aids to coagulation with iron salts fail to reduce the settling time required, the use of silicates with alum appears to be the best solution of this condition yet known.

(Interesting and perhaps a bit revolutionary was a statement by the authors that they were convinced that neither the time required for a floc to form nor its physical appearance can be used as a measure of coagulation efficiency. In conducting these tests they introduced what they believe to be an original method of evaluating coagulation results, based upon the time required to filter a given sample of coagulated water. In this case 200 c.c. through No. 12 Whatman filter papers. This, of course, must be done under standard conditions empirically determined to obtain what may be termed the "Filterability Index.")

Results by this method were found to be very much more accurate than they were able to obtain otherwise in making a study of flocculation efficiencies.

In commenting on the Lordley and Smith paper, Mr. Bardwell stated that coagulation was still a problem about which there was much to be learned. He cited the large floc formed by the addition of Sodium Zincate, but it was found to have no value in the removal of mud.

Question Box:

Just prior to adjournment of the sessions, two questions were read for replies from the floor.

1. For control of corrosion, are beds of crushed limestone more desirable than the feeding of lime?

2. What was the cause of taste and odor in a water supply containing Iron Pyrites?

Mr. Enslow was called upon to answer both questions. His answer to the first being that it was largely a question of overall cost and rate of flow. The limestone contact bed had the advantage of being foolproof and these had been used successfully to treat flows up to 50,000 gallons per day. He commented that these units take up quite a bit of space and therefore are not as practical in the larger plants as is lime feed.

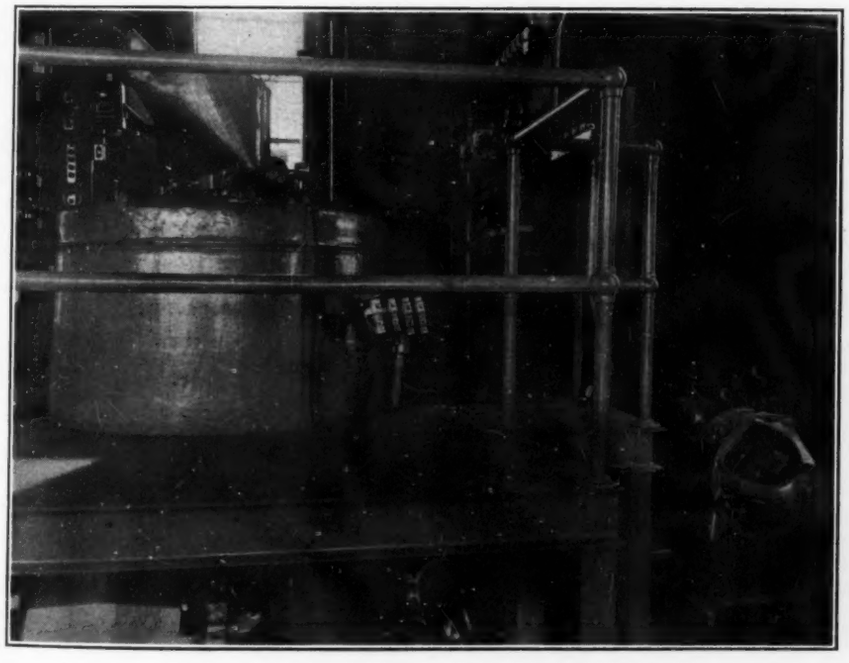
Replying to the second question, Mr. Enslow said that the odor was probably due to decomposition taking place in the bed during the time the filter lay idle at night. He recommended that the filter be treated with a concentrated chlorine solution to peptize the organic matter following which the filter should be thoroughly washed.

Adjournment

A CENTRIFUGAL EXTRACTOR AT ELIZABETH, N. J.

Transforms Sewage Slurry into a Fertilizer Cake

By L. J. MURPHY
Engineering Division
Westinghouse Electric & Manufacturing Company
BUFFALO, NEW YORK

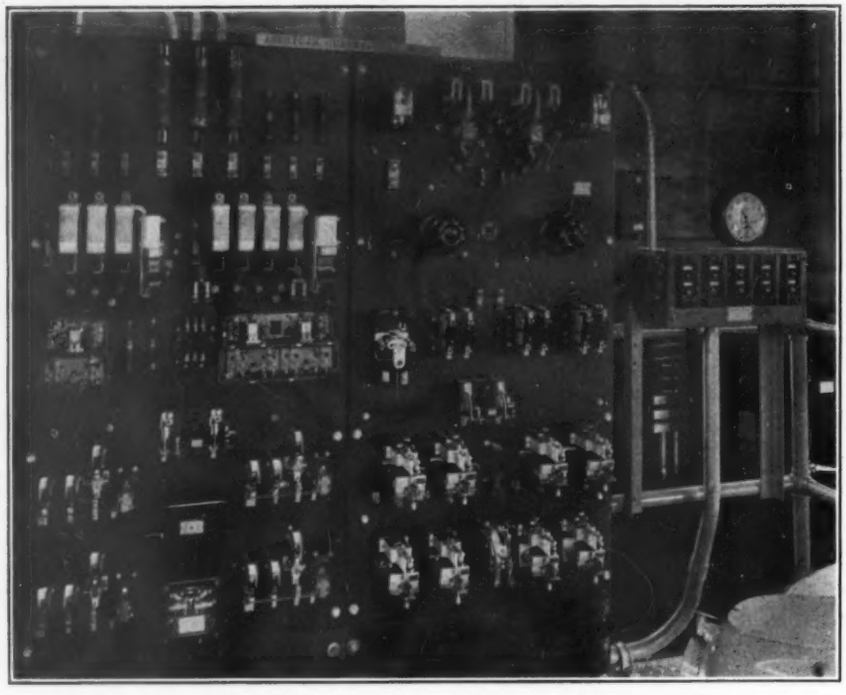


General View of the Centrifuge and Equipment

The main 60 H.P. driving motor, beneath the platform, does not show. The 75 H.P. motor-generator set is on the right; the control panel is at the end of the operator's platform. The feed spout and cutter mechanism of the centrifuge is plainly seen above it.

WORKING on the old principle of the centrifugal drier, a centrifugal extractor that transforms the wet solids of a sewage plant into a dehydrated cake which is proving useful as a fertilizer has been installed by the American Centrifugal Corporation at the Joint Committee Sewage Disposal Plant at Elizabeth, N. J. The extractor handles about 700 pounds of solid matter, in the form of wet sewage sludge, at one time.

Driving equipment and controls were furnished by the company with which the writer is associated, and consist of the following units—a d-c variable voltage motor-generator set composed of a 75-horsepower induction motor, a 50-kw d-c variable-voltage generator and a three-kw, 250-volt, d-c exciter; a 60-horsepower, 230-volt, 600 to 1800-rpm shunt-wound motor for driving the centrifuge basket or bowl; a one and one-half horsepower, 230-volt, d-c gearmotor with an output speed range of three-to-one for driving the centrifuge cutters; an a-c agitator motor for keeping the wet sludge stirred in the feeding tank; and a second a-c motor for driving the belt conveyor which carries the dehydrated sludge cake away.



The Control Panel and Operator's Push Button Station

The Machine

The driving motor is connected directly to the shaft of the centrifuge, which has a 44-inch diameter basket rotating about a vertical axis. Drive is furnished by a set of bevel gears which, with the motor operating at 1,800 rpm, turns the basket at 2,100 rpm. Inside the basket is a set of two combination feeding spouts and cutters, diametrically opposite each other and rotated by the cutter motor, through approximately 180 degrees according to whether it is desired to feed wet sludge into the basket or to cut the dried sludge out after the centrifuging is completed. Limit switches at either end of the travel of the cutters establish the limits of operation of the cutters and set up the circuit for complete automatic operation of the equipment.

Control of the speed of the main driving motor from 600 to 1800 rpm is accomplished by shunt field control and speeds below 600 rpm are obtained by control of the output voltage of the d-c generator.

Its Operation

Pressing the "start" pushbutton puts the 75 horsepower motor into operation through one step of starting resistance. As soon as the motor-generator set is moved up to speed, the exciter voltage builds up to a constant value, but the main generator operates at a low voltage, just sufficient to rotate the basket at a speed of approximately 90 rpm. Now, before any wet sludge is fed into the machine the operator presses the "fast" button, and immediately the cutters move away from the inside periphery of the basket and the spouts move out. When they have reached the limit of their travel, the limit switch shuts off the cutter motor, and sets up the circuit for automatic acceleration of the basket. On acceleration a fluttering field relay then automatically builds up the voltage of the d-c generator to its final value of 250 volts, limiting the current delivered by the generator during the acceleration period to 300 amperes.

As soon as the full voltage is reached, which corresponds to 600 rpm on the main driving motor, the sludge agitator motor is started up automatically and the slurry is fed into the basket through spouts located on top of the machine. At the same time a second fluttering field relay brings about further acceleration of the main driving motor by weakening its field, and limits the current through the armature to 300 amperes. A hand-operated rheostat determines the value of the final speed to which the motor accelerates the basket.

After a period of from 5 to 7 minutes of operation at top speed, the basket becomes lined inside with solid cake and a limit switch inside the basket is operated by the cake to immediately shut off the motor controlling the feed and automatically decelerate the main driving motor by regeneration through two additional fluttering field relays. [The first is to strengthen the field of the motor and the second to weaken the field of the generator.] As soon as the basket speed has been reduced to 90 rpm, the relay on the control panel starts the cutter motor in the cutting direction and starts the belt conveyor motor beneath the machine.

As the cake is cut out of the basket, it drops through four ports on to the belt conveyor and is carried away. As the cutters reach their limit of travel, a limit switch reverses the motor, and the cutters draw away from the inside periphery of the basket to the other limit of travel. The entire operation is then repeated and another batch of sludge slurry is converted into sludge cake dry enough to be incinerated or used on land as a soil improver.

Thaddeus Merriman Passes

Thaddeus Merriman, Consulting Engineer, and former Chief Engineer of the Board of Water Supply of New York City died on September 26th after a brief illness. He was 63 years old.

Mr. Merriman was born in New Haven, Conn., studied Civil Engineering at Lehigh University and was graduated in 1897. His Alma Mater bestowed upon him the honorary Doctor of Engineering degree in 1930. In 1905 he began his career with the New York City Board of Water Supply, becoming its Chief Engineer in 1922. Eleven years thereafter he retired (1933) to take up private practice, his most important work since having been in connection with the Colorado River Irrigation and Water Supply projects of the Southern California Metropolitan Water Districts.

Mr. Merriman, as Chief Engineer, fought to a successful conclusion the suit brought against the City of New York by New Jersey and Pennsylvania to prevent the Board of Water Supply from taking waters tributary to the Delaware River.

Mr. Merriman collaborated with his distinguished father in producing Merriman's Hand Book for Civil Engineers. He was a member and formerly a director of the American Water Works Association and several other professional societies and clubs. He is survived by his widow, one son and a daughter.

SLUDGE FILTRATION

Some Considerations in the Filtration of Raw vs. Digested Primary Sludges

*[The Fifth Article in a Series]**

By LeROY W. VAN KLEECK
Senior Sanitary Engineer
Connecticut State Dept. of Health
HARTFORD, CONN.

IN THIS, the concluding paper of the series, will be considered some of the desirable features for the future design of vacuum filter installations. Before proceeding with these features a few comparisons will be drawn between the conditioning and filtering of raw primary sludge as against digested primary sludge. The discussion which follows does not pertain to the filtration of raw activated sludge.

"To Digest; or Not to Digest"

"Will raw or digested sludge filtration best fit the local condition?" —That is a question frequently in the mind of the designing engineer. The following comparative statements are based on the writer's observations in connection with filtration of both types of sludge under Connecticut conditions. It is well in these discussions to bear in mind that, while digested sludge filtration has many advantages, the vacuum filtration of raw sludge, usually in combination with incineration, has been a great boon to the larger sewage treatment plants. In such cases a large digestion tank volume, the initial outlay of considerable capital, and an additional step in the treatment of the sludge are eliminated:

1. *Storage of Solids.* When raw sludge is vacuum filtered there is generally no storage space for this sludge other than in the sewage settling tanks or in small concentration tanks. If filter operations are disrupted, the disposal of the wet sludge in a satisfactory manner (by which is meant disposal without odor or fly breeding) is a real problem. The frequent remedy is the objectional by-passing of the raw sewage.

If the shut-down is for a limited time the solids can be stored in the settling tanks, but holding of the sludge for any appreciable period soon produces septic material which is odorous, more difficult, and more costly to filter. Septic conditions will occur sooner in hot weather. Holding the sludge in settling tanks soon affects the effluent.

*Earlier articles in this series by Mr. Van Kleeck dealing with "Sludge Filtration" appeared in March, June, July and August.—Editor.

The Author

Complete shut-downs or serious delays in the filtering schedule are more frequent than are generally supposed. Such interruptions may be caused by power failures, switchboard repairs, the break-down of scrapers in settling tanks, pipe stoppages, mechanical repairs to vacuum pumps, filtrate pumps, air blowers, motors, and cake conveyors, crew shortages from sickness or vacations, incinerator failures with attending delays and problems connected with the hauling of the filter cake to a suitable point for disposal, and other unforeseen difficulties. The writer has observed most of these interruptions at vacuum filter plants.

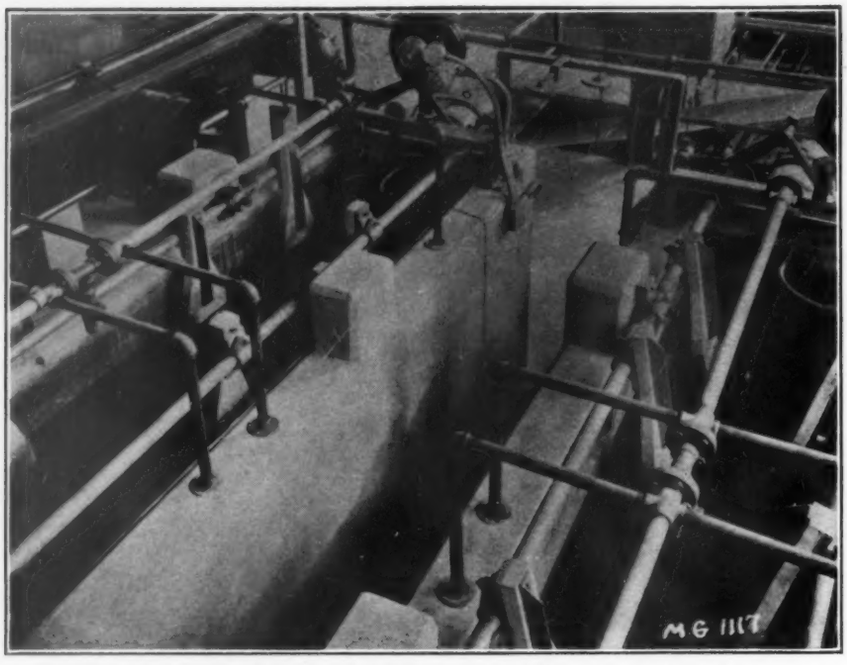
In view of the many possibilities of filter interruptions, a *"good place to put sludge"* is a strong argument for digestion tanks. Moderate-sized plants handling raw sludge might well be provided therefore with a storage tank of good size to serve as a holding basin for raw sludge during filter interruptions. Such sludge should preferably be held until partially or fully digested before filtering, or under certain local conditions the sludge might be dried on sludge beds or lagoons, with the aid of coagulating chemicals and deodorants.

2. *Odors.* When raw sludge is filtered there is a local offensive odor which is intensified in direct proportion to the staleness of the sludge. Digested sludge conditioned with lime emits an ammonia odor, which while frequently quite pungent, is not offensive. If digested sludge is elutriated, which eliminates the need for lime, no ammonia odor is present, and the filter room atmosphere is virtually odorless. The small tanks used for mixing the water and sludge in the elutriation (washing) process emanate a local gas odor rather similar to the odor observed when digested sludge is drawn to sludge beds. The odor from the tanks used for settling the washed sludge is very slight and strictly localized.

The odors from raw sludge filtration, which are the most objectionable, or from digested sludge conditioned with lime, can be controlled and greatly minimized by segregating the sludge conditioning tanks and filters from the remainder of the plant and installing suction fans for removing the odor to the roof of the building or other remote location. Cleanliness, deodorants and the prevention of sludge or cake spillage on the equipment or operat-

Middleton, Conn., Boasts this Attractive Treatment Plant Not Far Removed from Main Street

Modern to a detail, it provides vacuum filtration and incineration of sludge. Perhaps the first small plant to successfully adapt vacuum filtration of sludge.



The Sludge Mixing and Conditioning Tanks of Hartford, Conn.
Continuous-flow type, equipped with oscillating paddles providing a gentle swishing motion to the flowing sludge—Designed by W. A. D. Wurts, Ass't. City Engr.

ing floor are also of decided help in reducing odors, particularly when filtering raw sludge.

3. *The Filtering Schedule.* To avoid septic sludge, especially in the summer, the filters should be operated daily at a raw sludge filtration plant. This requires operation on Sundays and holidays, and a tight filtering schedule results. In the case of digested sludge considerable flexibility is possible. Usually week-end shut-downs are made and frequently the day shift does all of the required filtering as compared with the usual three-shift operation at raw sludge plants.

The digested sludge plant is thus afforded "breathing spells" for repairs and other work, the man-hours for operation are less, and by utilizing the available storage in the digestion tanks it is sometimes possible to withhold the filtering of sludge during summer vacations, sicknesses of the crew, and the other considerations listed under No. 1.

4. *Volume of Sludge.* The digestion of sludge reduces the volume of the sludge and the pounds of solids to be filtered. The actual reduction depends on the initial solids content of the raw sludge, the concentration of solids in the digested product and the completeness of digestion. The capacity of all units connected with filtration can be scaled downward when digestion is employed. For example, one filter may be provided where two would be desirable or required for raw sludge.

5. *Chemical Conditioning Costs.* Chemical conditioning costs per pound of dry solids filtered are lower at digested sludge plants in Connecticut than at raw sludge plants. [Such is apparently not always true elsewhere, particularly where the sludge handled is fresh.] Pre-chlorination of raw sewage during the hot months will help materially in securing a fresher sludge. More data on operating costs of conditioning will be watched with interest.

6. *Character of Filter Cake.* The character of digested sludge cake appears to have certain advantages over raw sludge cake under certain conditions, among which are:

(a) As a fuel, digested sludge cake is more uniform in volatile content, and while less volatile matter is available for burning, the uniformity of the cake simplifies incinerator operation. However, it is true that raw sludge cake has been and is being incinerated very successfully. It is entirely a matter of simplified operation in the case of digested sludge.

(b) When digested sludge cake is used as fill, cover is not necessary except for appearances, whereas uncovered raw sludge cake has some odor, which may be carrying and offensive, and may attract flies. The fire hazard from raw sludge dumps has been previously pointed out. Consequently, the safe and sanitary disposal of raw sludge cake as fill, involves additional expense for adequate earth cover and the provision of earth fire walls.

(c) As a soil conditioner, digested sludge cake is less offensive, generally drier and has a greater humus content. The possible objection to ferrous iron in raw sludge cake has been previously mentioned. Against these objections must be balanced the greater volatile content of raw sludge, although this volatile or organic matter is not in a humified form. The hygienic considerations are also important, and except for orchards, forage crops and like uses, raw sludge cake should not be used for fertilizer unless the pathogenic bacteria which may be present are destroyed by heat drying.

7. *Constancy of Sludge Quality.* Digested sludge is generally of fairly constant quality with respect to per cent of dry solids, volatile content and pH. It does not subject the filters to shock loads of industrial wastes, particularly from intermittent discharges of oil and grease, which cause cloth blinding and interference with sludge conditioning. *The elimination of oil and grease from filtering operations has great practical significance.* This constancy in digested sludge, particularly in its solids content, simplifies sludge conditioning.

With raw sludge, ample sludge concentration storage, possibly combined with arrangements for mixing to aid in securing a uniform sludge, will to a considerable extent reduce this problem.

8. *Use of Batch-Mix Type of Sludge Conditioning.* Batch mix conditioning of sludge is the most economical and convenient method at the smaller plants. (Plants filtering say 5000 to 10,000 gallons of sludge per day). With this type of conditioning, digested sludge is better adapted as the floc produced with it is more stable.

9. *Filter Rates.* The filtering rates at plants in Connecticut are higher with digested sludge, although this may not necessarily be true elsewhere.

10. *Character of Filtrates.* The filtrate from conditioned digested sludge is chemically of better quality than that from raw sludge. Comparative figures were given under "laboratory control" in paper No. 4 of this series which appeared in the August issue. This is not, however, an important consideration as the filtrate from either type of sludge is readily handled without trouble and is greatly superior, analytically, to the liquor from digestion tanks. In this connection, therefore, raw sludge filtration may be considered advantageous, since the digestion tank overflow liquor problem is eliminated.

11. *Use of Digestion Tank Gas.* When digestion tanks are used, the by-product gas is of considerable value as a fuel for gas-fired boilers or engines. This utilization defrays some of the cost of tank installation.

Based on the above considerations and first hand observations, the writer believes that small to moderate-sized plants dewatering sludge with vacuum filters might well consider the filtration of digested rather than raw sludge.

Future Design of Vacuum Filter Lay-Outs

We have touched lightly in earlier articles on desirable features for the design of vacuum filter installations. The present section will discuss in some detail a few of the items which should be given particular attention by the designing engineer and filter manufacturers. In some cases these may even now be realized by minor alterations at existing filter plants.

Sludge To Be Handled. If raw sludge will be filtered, the designer should be sure of a reasonably fresh

sewage throughout the year, or at least one that can be controlled by pre-chlorination. If digested sludge is to be filtered, an ample digestion capacity to secure a well-digested sludge might well be aimed for. Even small-scale digestion experiments in 5-gallon or larger jugs may furnish valuable data in making plans for digestion.

Sampling Points. Designers should always provide means for the suitable sampling of the unconditioned sludge, the conditioned sludge and the filtrate. The desirability of securing samples of these materials has been discussed under "laboratory control."

Shower Pipes. Shower feed pipes (for washing the filter cloth) should not be less than 2 inches in diameter. A pressure of about 35 lbs. per sq. in. at the shower is desirable. Double clamps should be used for attaching the flexible hose piece to the supply pipe to prevent water leaks and to protect the operators from unexpected drenchings.

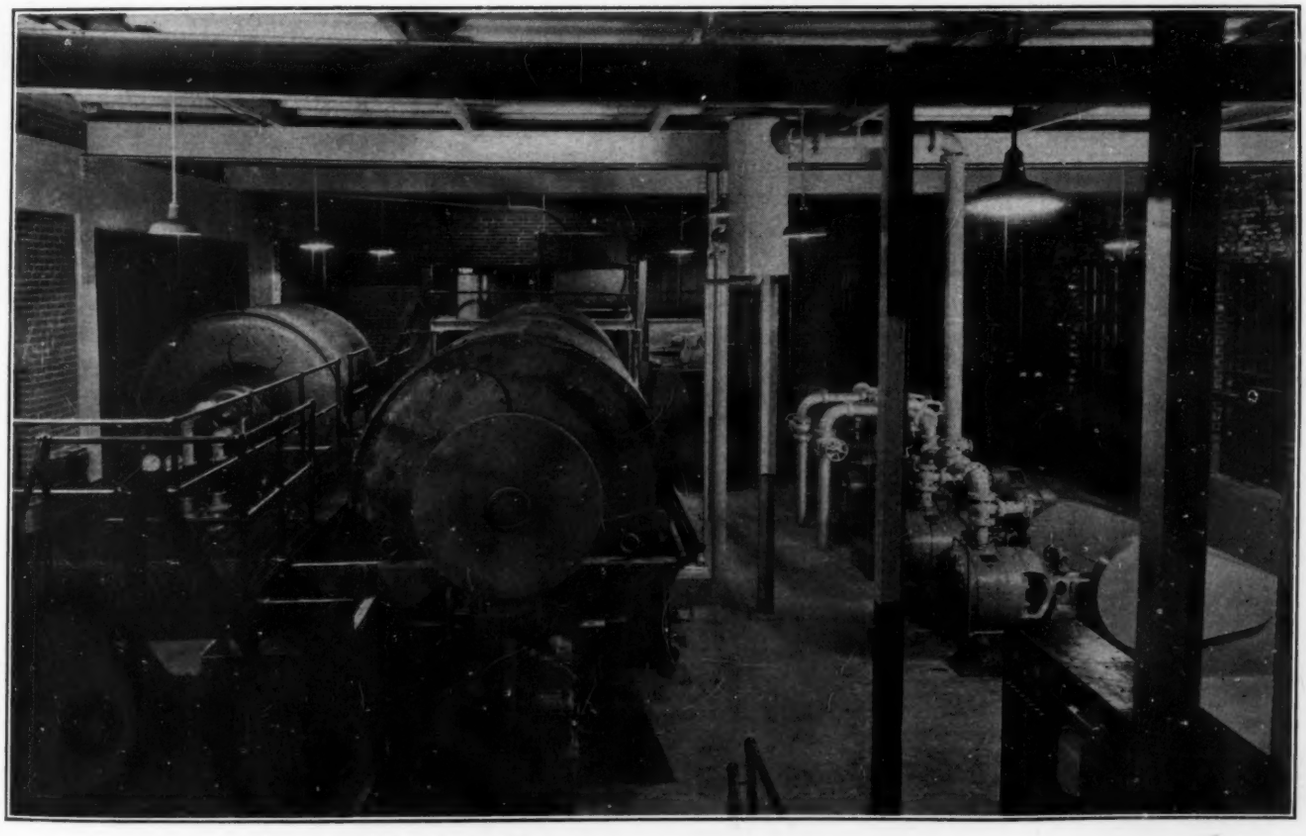
Feeding and Storage of Chemicals. In continuous-mix sludge-conditioning, independent control of the chemical feed and sludge rate is desirable. It is a good plan to provide for 24-hour storage of the ferric chloride solution. Stirring apparatus in the storage vats is of benefit for occasional mixing. Such will reduce the tendency of separation of the liquid, which results in a weaker solution as the vat is lowered.

The lines carrying ferric chloride solution should be of heavy rubber hose or rubber-lined pipe. The bolted flanges on hard-rubber pipe, at one plant familiar to the writer, have leaked and it appears that such pipe may give trouble. Rubber-lined pipe should be very suitable for ferric chloride and can now be obtained in small sizes.

It is preferable to feed either ferric chloride solution or milk of lime (rather than dry lime) to the sludge conditioning tanks. Gravity feed is preferred to the use of bucket-conveyors or pumps, particularly so, because ferric chloride can be handled only in specially lined buckets or pumps. The use of mechanical equipment for feeding either solution results in maintenance troubles and extra cost. These seldom over-balance the cost of raising the bulk chemicals from the basement to an upper floor. A freight elevator should, of course, be provided, when the chemicals are used on an upper floor.

Since the cost of dry ferric chloride or lime is considerably less in carload lots, designers should provide the necessary storage space at the plant. Storage rooms should be segregated from the rest of the plant and be provided with dust-proof partitions. Concrete is the most suitable floor material.

Sludge Concentration Tanks. It appears very desirable to furnish these tanks regardless of the type of sludge to be handled. Cylindrical deep tanks are prefererd by the writer to square or rectangular ones, since the former allow for greater concentration of sludge and are easier to clean. Multiple supernatant draw-offs at 1½ to 2-foot intervals are desirable to provide flexibility. Facilities for flushing or filling the tanks with water or sewage should be included. The tanks and all piping should be protected from freezing. The tanks should not, however, be located in too warm a room. A cool atmosphere will retard "working" of the sludge. The use of compressed air or perhaps mechanical mixers in such tanks has been previously mentioned. In some cases



The Filter Room at New Britain, Conn.

Note elevated platform for filters, adequate night lighting. Vacuum pumps and air compressors show on right; ferric chloride and lime feeders show in background above filters. The latter feed by gravity to conditioning tank beneath, also with gravity flow of conditioned sludge to filter vats. It is a well designed arrangement for minimizing operating troubles.

sludge concentration tanks are used for diluting heavy sludge with filtrate, water, or sewage before conditioning.

Valves and Sludge Feed Piping. The valves used on conditioned sludge piping should be of the *full* opening type. Plug valves without full opening, and the like, clog with sludge, bits of rags, small sticks, etc., and interrupt the filter feed.

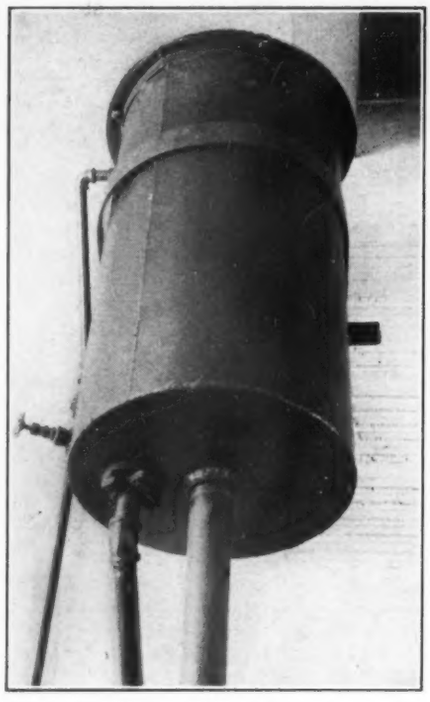
The minimum size for pipe connecting the conditioning tanks and filters should be 6 inches, and preferably 8 inches. These sizes should be used irrespective of the type of sludge or the available head. Three-inch pipes carrying conditioned sludge frequently clog and do not feed the sludge rapidly enough to the filter vats to keep these vats at the proper operating level. At other plants 4-inch pipes have clogged or resulted in too slow a feed. Not only does slow feed cause difficulty in the maintenance of a proper vat level, but the additional holding time of the conditioned sludge is undesirable and sometimes affects filtering. The pipes carrying conditioned sludge should have as short a length as possible.

When a single sludge pipe feeds two or more filters there is frequently difficulty in obtaining an equal distribution of the sludge. Friction losses, caused by pipe bends, valves, differences in length, etc., create this condition. When friction is introduced at the point of greatest sludge flow by partially closing a valve, clogging is the frequent result. Individual pipes to each filter are preferable.

Filter Vat Drains. Drains should always be provided for each filter and they should have a minimum diameter of 4 inches. The drains should discharge to the sludge concentration tanks, raw sewage, or digestion tanks, if provided. So that a vat can be drained, the cloth washed, and filtering operations resumed without upsetting the conditioning process, they should not discharge to the conditioning tanks.

Filter Room Floors. Filter room floors should be constructed of concrete or other waterproof materials and sloped to a drain of adequate size. Filter cake and sludge are frequently spilled around filters and means for hosing the floors with water are of great aid in cleanliness, odor control and appearance.

Control of Sludge Feed. A wide range of capacity should be specified for pumps or bucket elevators used for delivering unconditioned sludge to the conditioning tanks.



Home-made Elevated Water Tank for Separating City Water and Vacuum Filter Equipment

It has float-controlled inlet valve. See paragraphs on "Cross Connection Hazards."

Gravity flow of conditioned sludge to the filters is strongly recommended, rather than pumps, elevators or other mechanical lifters to avoid the additional sludge agitation produced by such devices.

Sludge Conditioning Tanks. Continuous-mix tanks should preferably be rectangular in shape to reduce short-circuiting. The judicious use of baffles is helpful. Batch-mix tanks might preferably be circular with conical bottoms to prevent sludge and chemical residue collecting in the corners. Tanks for sludge conditioning are generally made of concrete or coated metal.

In general, mechanical agitation appears superior to compressed air for mixing of the sludge and chemicals. Air tubes and plates clog rather readily and are troublesome to clean. Air also tends to escape too rapidly, resulting sometimes in ineffective or erratic mixing. Mechanical mixing should be reasonably smooth and slow to insure good mixing and to avoid undue agitation of the forming floc. The mixing device should have an adjustable speed, no metal parts should come in direct contact with ferric chloride and short-circuiting of the sludge should be avoided. The accompanying photograph showing the Hartford, Conn., conditioning tanks, as designed by W. A. D. Wurts, assistant city engineer, embodies these points admirably.

The present trend toward the use of screenings grinders and cutters sometimes result in balls or strings of material forming in raw sludge conditioning tanks. Secondary coarse screening should be provided for removing such material ahead of the conditioning troughs.

Protection of Vacuum Pumps. Reciprocating dry-vacuum pumps should be protected against the entrance of filtrate. The centrifugal type also needs protection, although it is less subject to damage. Vacuum breakers, operated by floats in the filtrate receiver, are sometimes provided to break the drum vacuum by admitting air from the atmosphere whenever the filtrate level exceeds a certain depth. The occasional operation of these breakers is not objectionable but a frequent cutting off of the vacuum in the filter drum affects operation. The latter condition might be caused by under-capacity filtrate pumps, too small a filtrate receiver, or excessive back-pressures.

The most fool-proof arrangement, and the one recommended, is a barometric leg of about 32 feet at which height the vacuum pumps pull their vacuum. Since the filtrate cannot rise to the height of this leg, the vacuum pumps are protected. The vacuum tank is in such cases generally located near the roof of the filter building, but the filtrate receiver may be situated on the operating floor.

Noise Reduction. For those installations where vacuum pumps, air compressors and filtrate pumps are operated by individual motors, this equipment might preferably be located in the basement apart from the filters. This reduces the noise on the operating floor and incidentally provides additional height for the barometric leg recommended above.

Control of Odors. Unless elutriated sludge is being filtered, exhaust fans in the filter and sludge conditioning rooms are worthwhile for odor control. Exhaust to the roof is best.

Cake Conveyors and Sludge Cake Storage. Conveyors for cake are generally belts or metal elevators. In either case the conveyor should be provided with high sides to prevent spillage on the floor and steep slopes should be avoided so that the cake will not roll down the incline into balls.

If a storage bin is provided, the cake should discharge into the hop-

per center and not on the edge, otherwise the cake will pile on one side of the bin and require considerable manual handling. Steep hopper sides and wide bottom openings are needed to minimize cake sticking. (See illustration of West Haven, Conn., storage hopper.) Electric vibrators are available for attaching to the sloping sides of sludge cake and incinerator ash hoppers to loosen material "hung-up" in the bins.

When the cake is fed directly to an incinerator, the furnace feed should be designed to prevent clogging by a wet cake and to deliver the cake to the furnace over a flexible load range to harmonize with the filter yields. Screw-conveyor feeders have proven satisfactory provided they have sufficient capacity. Roller-type feeders are also used but tend to clog with wet cakes unless preceded by a screw-conveyor. At one Connecticut plant a roller-type feeder was replaced with a sliding-plate type to correct this latter difficulty. Furnace feeders have given trouble and deserve the careful consideration of designers and manufacturers.

In cases where only one incinerator is provided, a by-pass cake conveyor to the outside of the building should always be installed.

The filter cake may then be readily carted in trucks, if the furnace is being serviced or is not in use for any reason. In raw sludge filtering it should in addition also be possible to remove the cake manually at the filters, if the mechanical conveyor fails.

Location of Filter Exhausts. Filter exhausts are audible for a short distance and in many cases have an odor. The odor with raw sludge cake is offensive; from digested cake pungent (a mild to pronounced ammonia odor is the principal characteristic), and from elutriated sludge practically negligible. Depending, therefore, on the type of sludge being filtered and the nearness of houses, exhausts should be located to avoid a nuisance. Mufflers reduce the noise somewhat although this is not as important a consideration as the odor. Outlets to atmosphere at the roof of the operating building or submergence in a sewage well are two satisfactory dispositions of filter exhausts. Local conditions generally suggest special locations.

Filter manufacturers recommend as direct and short an exhaust line as possible to avoid vacuum pump backpressures. Pitkin, of Oliver-United Filters, recommends that each vacuum pump have an individual exhaust of the full diameter of the pump exhaust or greater.

Looking Down into a Circular Sludge Thickening Unit—Deep and Small in Diameter

Note the thickening mechanism. The tank is equipped for chlorine feed to retard septic action if and when desired.

Cross-Connections. Cross-connections constitute any physical connection whatever between potable water piping and sewage or other filth. Such connections are an ever lurking danger and have unfortunately made their appearance on vacuum filters as on other sewage plant equipment.

Potable supplies have been used as sealing water for vacuum and filtrate pumps and for sludge pipe flushing purposes. The first type of direct connection can be avoided with the use of a small float-operated elevated-tank supply which will segregate the potable water from any direct physical connection with the pumps. (See accompanying illustration of such a tank.) The second type of connection can be avoided by temporary hose connections. In many cases effluents from secondary treatment or filtrate water can be used instead of water for the above purposes.

Safety Measures. The safety features to be considered in the operation of vacuum filters are confined principally to the avoidance of physical injuries and infections, the latter applying primarily to the handling of raw sludge. The space provided for the filters should be ample—*avoid crowding of filters and their appurtenances.* Elevated filters should be equipped with handrails, non-slip treads and properly spaced steps to facilitate operation.

The filter room should be provided with ample light, preferably both natural and artificial lighting.

Inspection of the conditioned sludge, observation of the sludge vat level, operation of the washing shower, scraper adjustments, switch control and filter-cloth replacement jobs should be accomplished with minimum inconvenience. In connection with several of these routine duties the construction of elevated platforms will facilitate operation. Such platforms are particularly useful for cloth changing operations.

Infections are largely the result of carelessness. Operators should minimize direct contacts with raw sludge. The hands should be washed with hot water and soap before eating. All skin breaks should be treated with tincture of iodine or other effective bacteriacidal agent.

Conclusion

In this series of five articles an attempt has been made to outline some of the many considerations in the operation and design of vacuum filters for sludge dewatering. The process has, over a relatively recent period, proven practical for a variety of sludges and has produced a final product amenable to disposal by burning or as fill or soil improver. More important it has accomplished this mechanically, in a small operating space, under controlled conditions, with the production of an easily handled waste liquor which does not burden or adversely affect the regular sewage treatment facilities. It would appear that as more is learned of the mechanics of vacuum filtration and particularly of sludge conditioning, the process will grow in popularity and its field of application will be extended.

New Hampshire Has a Water Works Association

Recently water works men in New Hampshire gathered together and formed the New Hampshire Water Works Association, under leadership of the engineering staff of the State Department of Health and Percy Shaw, Supt. of Water Works at Manchester (now president of the New England Water Works Association), who was elected the first president of the New Hampshire Association.

We note that the Association is adopting the commendable practice of calling on the municipality or water company to carry membership and pay dues. Such a Corporate Membership automatically entitles water works officials to full membership, without payment of dues individually.

With an ambitious stride, the New Hampshiremen are now considering the production of a Journal. The Secretary is Leonard W. Trager, State Department of Health, Concord, N. H.

LONG ISLAND SECTION

Meets at the "University of Activated Sludge"

At Tallmans' Island

(1) An aeration unit, with power house in the distance; (2) "Hank" Liebmann, Design Engineer, "Al" Johnstone of Wallace & Tiernan Co., "Dick" Gould, Chief Engineer, Dept. of Public Works; (3) Chlorinator House on each side of which are the sludge thickening tanks which have proved a boon to operation.

Sludge Meter Booth
Tallmans' Island Plant

FOR one of the regular quarterly meetings of the Long Island Section of the New York State Sewage Works Association members gathered on the afternoon of August 31st at the new Tallmans Island Sewage Treatment Plant of New York City, located but a mile or two from the New York World's Fair which it serves along with surrounding territory.

Sam L. Tolman, Supt. of Wards' Island Plant, and Nathan Kass, Engr. in Charge of Sewage Treatment Plants, N. Y. City

Members spent the afternoon inspecting the plant, to find the activated sludge process doing a splendid job in which its designers and operating staff have just rights to be proud. Employing the tapered aeration principle, sludge thickening and several other innovations, plant performance in this writer's opinion (economically as well as technically) has rarely if ever been surpassed for any continuous period. We would vote this plant an award (based on design, operation and performance) if the occasion presented itself.

Boasting the largest installation of gas engines in America (8 units, 3500 H.P.) members saw these prime movers clicking away driving sewage pumps and air blowers in one of the most pleasing stations in appearance that we know of at any sewage plant.

Amused Head Tablers—Gould Speaking

From Left—Walter D. Binger (Guest Speaker); Wellington Donaldson (the Chairman); Lawrence Luther (the Secretary); Richard Gould (speaking); Nathan Kass; Henry Liebmann. [Something got in the way of the camera. It proved to be Mineola's "Teeney" Hall.

What is more, members learned that the takings of city gas to supplement digester gas in producing the whole of the plant's power requirement had been less than anticipated. Further, that with a slight trimming of air requirements no city gas will be required, and the already low operating cost be still further reduced. Considering the sewage lift in addition to power for blower operations, if the time comes when digestion produces 100% of power requirements at Tallmans Island a new chapter will have been written in the history of activated sludge plant performance and economics. Even now the Tallmans Island Plant, of designed flexibility and manned by a finely trained operating force, may be termed the "University of Activated Sludge"—not to deny the fact that it is New York's "pet plant" in which much concerning design and operation of its plants of tomorrow is being developed and transferred to drafting boards.

Tallman's Island Operating Staff

(Left to Right)—Giammateo; Holm; Kelleher; Sholes; Sparr; Henry Rath (Plant Engineer in Charge); Hirschel; Learmarth; Fenton.

The Evening Program

Following the inspection the customary Dinner Meeting was held, with Wellington Donaldson, Director of the Bureau of Sewage Disposal, presiding as chairman and toastmaster.

The first speaker introduced was the man responsible for the Tallmans Island Plant design, Richard H. Gould, Chief Engineer and Acting Deputy Commissioner, who outlined some of the work under way in extending sewage treatment in the New York City area. In the immediate program, involving 148 M.G.D., nearing completion is the 40 M.G.D. Bowery Bay (North Side Queens) Plant of activated sludge design, which ultimately is to be an 180 M.G.D. plant. Under construction is the 60 M.G.D. Jamaica Bay Plant (South Side)—also an activated sludge plant; and the Coney Island Plant extension soon to provide chemical treatment for 70 M.G.D. when the 35 M.G.D. enlargement is completed. Under design is the 65 M.G.D. 26th Ward Plant for Brooklyn. Mr. Gould, handicapped by a bad cold, found it necessary to curtail his review considerably, but the picture of the speaker in action reveals that he was still able to tell a good yarn.

Binger Guest Speaker

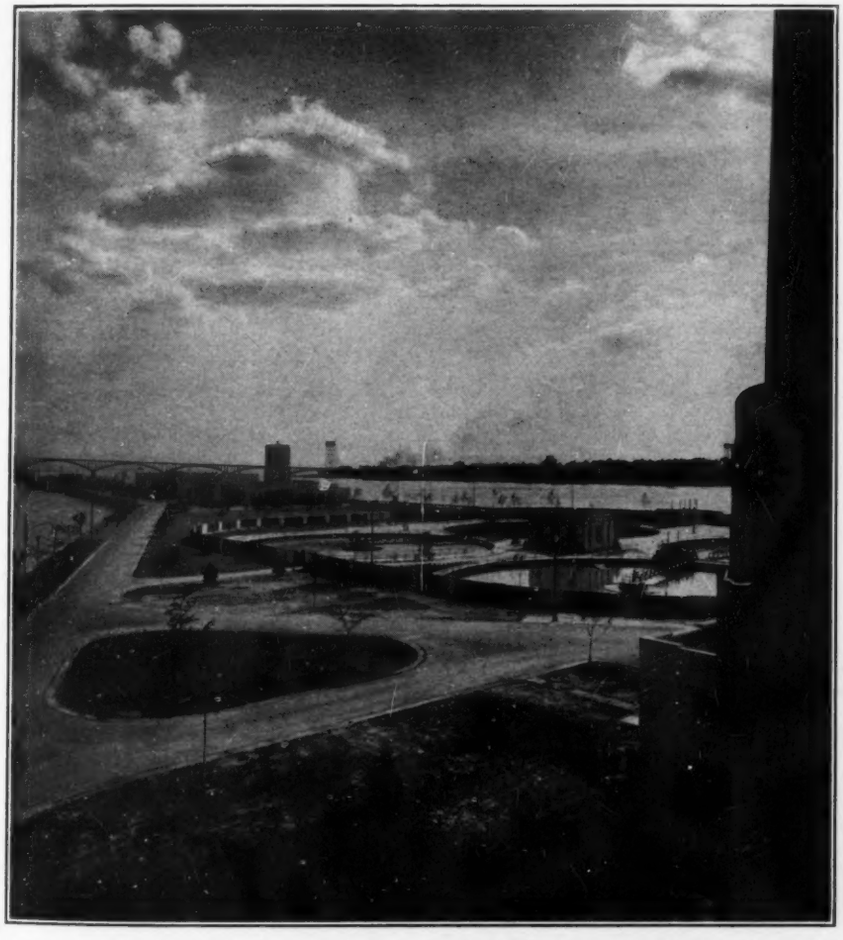
The next speaker introduced was Walter D. Binger, Commissioner of Boro Works and former Engineering Commissioner of Sanitation at the time when Tallmans Island Plant was projected. Commissioner Binger, who has been considerably missed by the sewerage fraternity, revealed how he and Chief Engineer Gould had come to select the location of the Tallman's Island Plant and thereafter had interested Mayor LaGuardia in pushing it through to completion as "The World's Fair Plant." With this and the Bowery Bay Plant in operation no more sewage will be entering Flushing Bay after October.

It was especially interesting to hear Mr. Binger say that on Sunday as many as 4,000 people had visited the attractively designed Tallmans Island Plant, located alongside of one of Long Island's newest parkways.

In order that members might take in the World's Fair, no technical program had been arranged and the meeting was adjourned an hour earlier than customary for the quarterly meetings.

BUFFALO'S NEW TREATMENT WORKS DEDICATED

Canadian Officials Attend Exercises

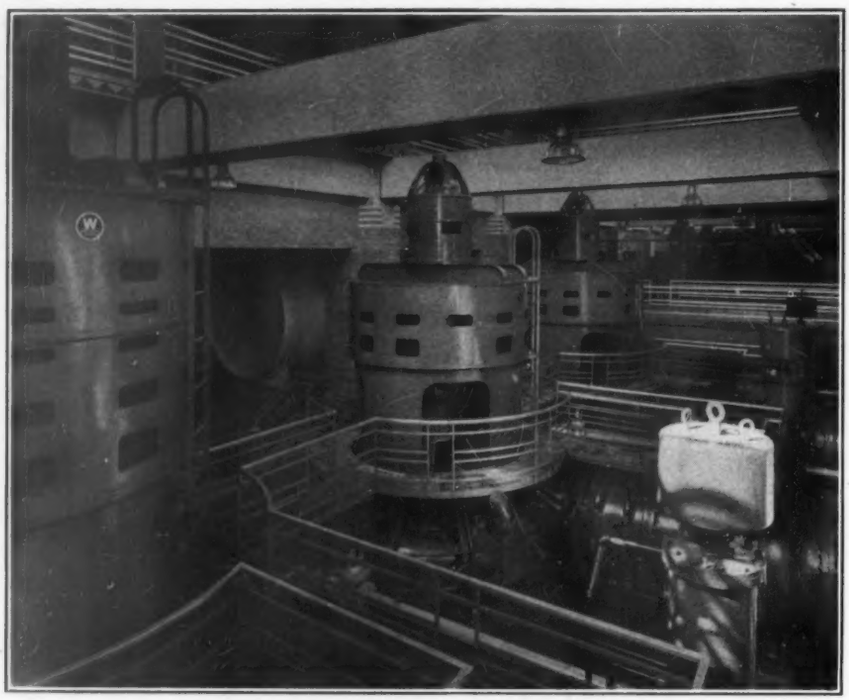


Buffalo's $4,500,000 Treatment Works on Bird Island, Dedicated Sept. 12, 1939.

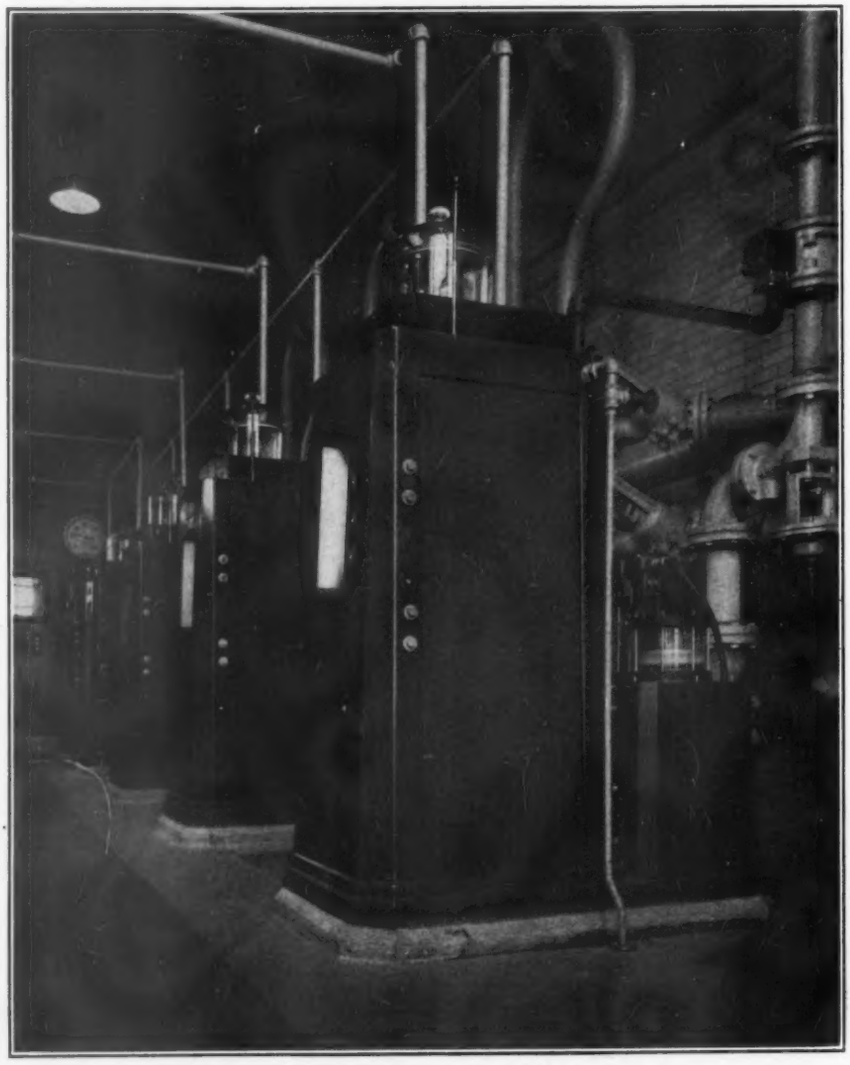
AFTER several years of continuing efforts on the part of New York State's health authorities to get pollution along the Niagara Frontier cleaned up, the crowning achievement is the new Sewage Treatment Plant of Buffalo, which has been in service now for 15 months. Little wonder then that the dedication of this $4,500,000 plant (part of a $15,000,000 sewerage program) was made an occasion when on Sept. 12th notables gathered to witness or take part in the ceremonies of dedication.

When engraved invitations are issued to a sewage works dedication, and 1,500 people are expected to attend, that spells *news* in progress and interest in sewage treatment such as this country has never before known—nor any other country to our knowledge. Inclement weather caused abandonment of the out-of-doors ceremonies and the stands erected for the occasion were empty. But, mark you, the indoor attendance ran roughly to 500, many from a distance.

As the principal speaker, came John M. Carmody, Administrator of the new Federal Works Agency. Other notables on the speakers' platform were D. H. McCarragher, Chairman of the Buffalo Authority, who introduced amongst others—



Six Giant Motor-Pump Units. Each with a capacity of 120 M.G.D. against 23 ft. head.



Five Fully Automatic W&T Chlorinators. Each with a capacity of 3 tons of chlorine per 24 hours.

Buffalo's Mayor Holling, New York's Senator J. M. Mead, Congressman W. G. Andrews (Buffalo District), Congressman P. L. Schwert, C. A. Holinquist, N. Y. State Director of Sanitation, Dr. A. E. Berry, Chief Engr., Ontario Dept. of Public Health; H. W. Keitzell, vice-chairman of the Authority; Messrs. Samuel Greeley and Paul Hansen, Chicago consulting engineers on the $15,000,000 project; Col. M. E. Gilmore, P.W.A.'s Regional Director, and Harold Epstein, General Manager for the Authority.

The accompanying photographs give some idea of the effective and pleasing layout of the plant on Bird Island and the size of the undertaking is indicated in the picture of the 6 giant pumps and motors. Likewise, by the chlorinator installation which represents the largest in the world to date.* A battery of 5 giant machines, each with a capacity of 6,000 lbs. per day, provide prechlorination. The plant provides primary treatment and incinerates solids taken from short period digestion tanks and dewatered on vacuum filters.

The Buffalo Project was made possible through P.W.A. assistance and an outright grant of $6,750,000.

*When Detroit's new Treatment Works go into operation the palm will go there.—Ed.

Computing Footage Wound on Reels or Drums

(Addenda)

In our September issue appeared a brief item bearing the above caption. It presented a very simple procedure and formula for calculating the length of rope, wire, cable, hose, etc., wound on reels or drums. The factor given for use with the formulæ was 0.3.

Mr. Schaphorst, who contributed this useful formulæ was asked if the same factor (0.3), which applies in the case of round materials, also applied in the case of square materials such as packings or braided yarn.

He regretfully had omitted to add a factor for such materials, and now wishes to state that for square materials the proper factor is not 0.3, but is *0.26*.

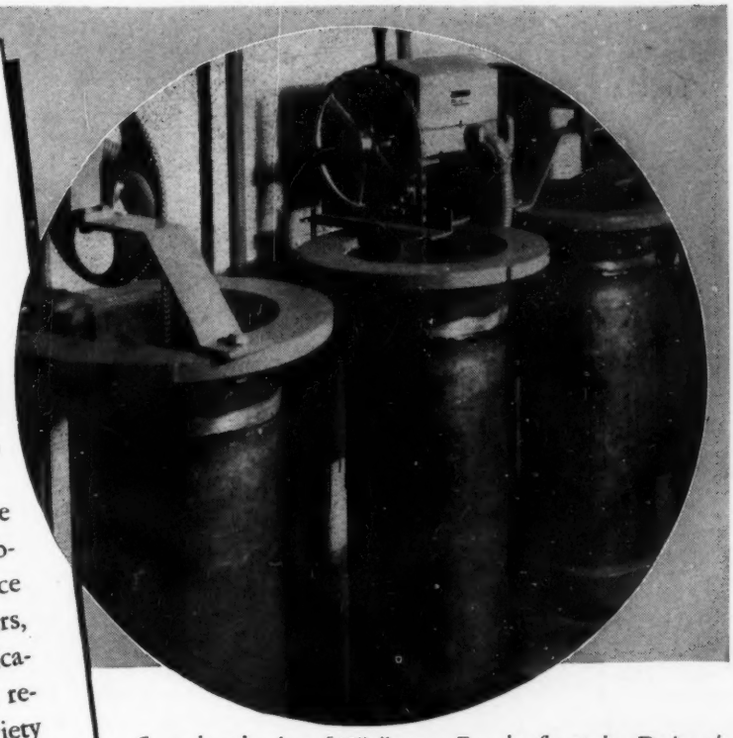
If our readers will insert this factor for square materials as a marginal note on page 336 of the September issue, Mr. Schaphorst's contribution will then possess added value.

Everdur

is backed by competent advisory service

Engineers of The American Brass Company offer their assistance in advising on any problem having to do with the application of this copper-silicon alloy to sewage, reservoir, or waterworks service.

Their experience covers a period of twelve years during which EVERDUR has established a unique record in these fields. Since 1927, for fine screens, gates, aprons, weirs, and many other sewage treatment applications, it has shown uniformly excellent resistance to corrosion through a wide variety of operating conditions.



Control mechanism of 12" diameter Everdur float tubes. Designed and built by Krajewski-Pesant Mfg. Corp., for the Ward's Island Sewage Treatment Works of the City of New York.

Only EVERDUR combines—

1. High resistance to corrosion . . . **2.** High strength, permitting lightweight construction . . . **3.** Ease of fabrication . . . **4.** Ready weldability . . . **5.** Moderate cost.

Everdur Metal is available in all commercial forms and can be readily fabricated by substantially the same procedures used with steel, including welding. Let us send you Publication E-11 which describes the use of this Anaconda alloy in the sewage treatment, reservoir and waterworks fields.

• • •

One of nine gates installed in the Richmond-Sunset Sewage Treatment Plant of the City and County of San Francisco, Cal. The gate bodies are EVERDUR castings, the lifting stems were made of 1-1/2" EVERDUR rod, the guides from brake-formed EVERDUR angles. All reinforcement cross bars, as well as all nuts, bolts, washers, etc. are EVERDUR. Equipment fabricated and installed by the California Corrugated Culvert Company. 39148

ANACONDA

Everdur Metal

Visit the Copper & Brass Industry Exhibit in the Metals Building, New York World's Fair—1939.
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MATHIESON SANITATION SERVICE *Proves its worth* TO MODERN WILMETTE, ILLINOIS

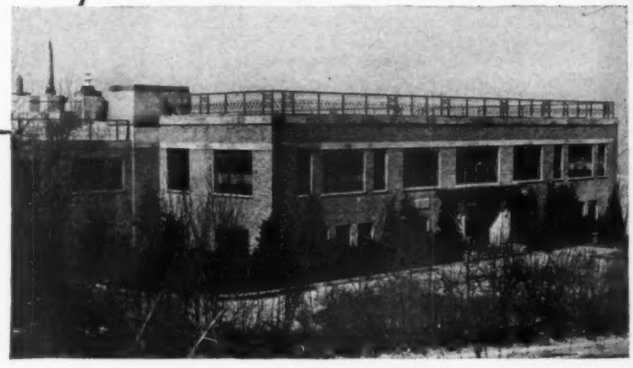
. . . Says Gerard S. Noerenberg, Chemist, Wilmette Filtration Plant

"We have been users of your Chlorine for about nine years with an intermediate gap when we used another source of supply. This experience (sticky valves) fully confirmed our belief that Mathieson service is both dependable and advantageous to us. Your product has been uniformly good. There has been no trouble with sticky valves.

"We also use HTH in its convenient packaged form, in a number of ways. It is used as a stand-by emergency source of Chlorine in our Filtration Plant, to sterilize all new mains and reservoirs and as a health help in the prevention of Athlete's Foot in the Waterworks locker room. The public bathing beach has been using HTH for years in the showers and locker rooms. In the outlying districts, HTH is used in the sterilization of wells.

"Not the least of advantages in using your products has been the friendly, constant and able assistance given us by your representative, who stops in on us frequently."

Gerard S. Noerenberg, Chemist, Wilmette Filtration Plant.



Lake Michigan Filtration Plant, Wilmette, Illinois.

● Whether the job in hand be water purification, sewage treatment or swimming pool sanitation, you have a right to expect a dependable supply of liquid chlorine—a pure product, trouble-free containers and valves, prompt delivery service. It is because Mathieson Chlorine has proved itself in these three essentials that so many communities like Wilmette, Illinois specify "Mathieson" when there is a chlorinating job to be done.

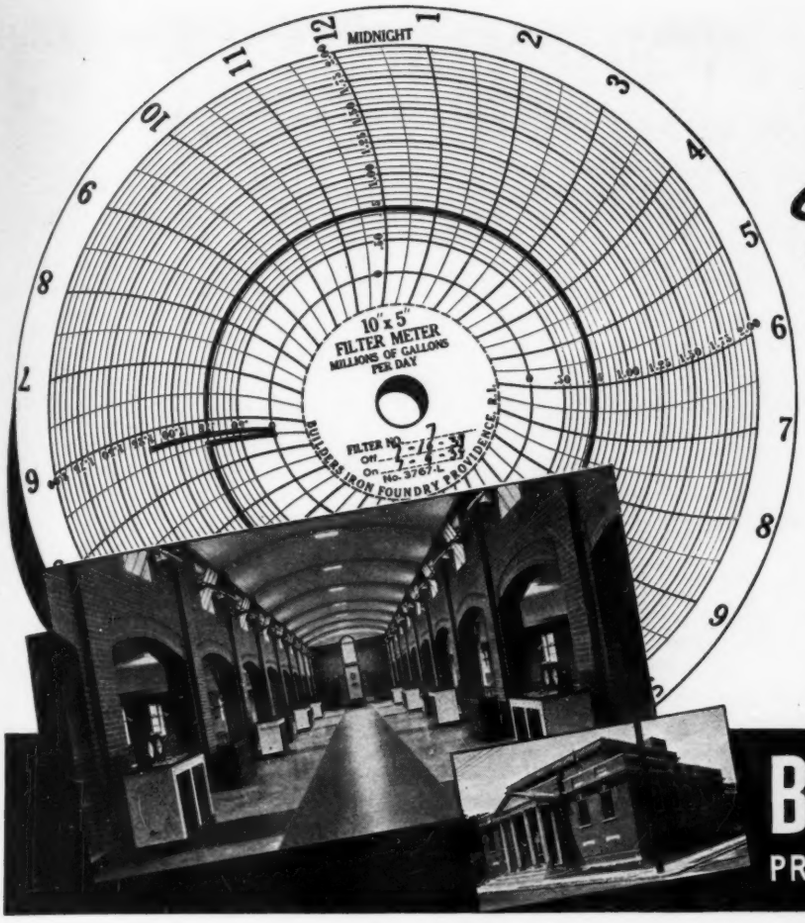
Mathieson Chlorine, coupled with HTH for special and emergency jobs that so often arise, make a team hard to beat for dependable sanitation service.

HTH comes in 5-lb. cans with replaceable caps, packed 9 cans to the case; also in 75-lb. drums.

THE Mathieson Alkali Works (INC)

60 EAST 42ND STREET, NEW YORK, N. Y.

LIQUID CHLORINE . . . HTH . . . SODA ASH . . . CAUSTIC SODA . . . BLEACHING POWDER . . . BICARBONATE OF SODA . . . AMMONIA, ANHYDROUS and AQUA . . . PH-PLUS (FUSED ALKALI) . . . DRY ICE . . . CARBONIC GAS



Smooth Control
AT LAWRENCE, MASS.

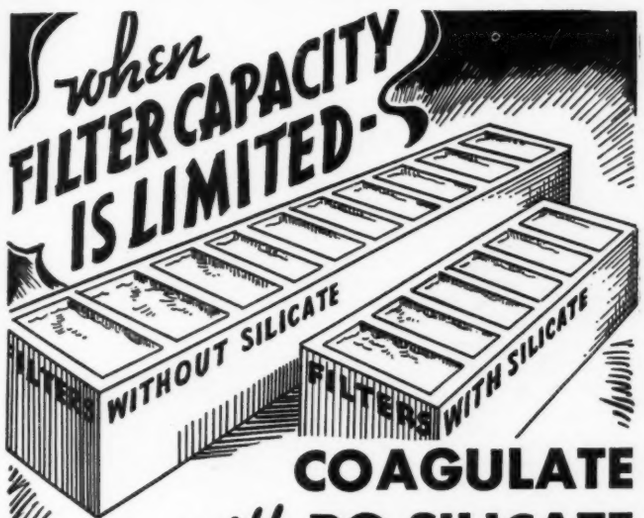
Consulting Engineers, Metcalf & Eddy
Contractor, James A. Munroe

Another fine filtration plant has been placed in operation with eight Venturi Direct-Acting Controllers on the job. The chart from one of the Builders Rate-of-Flow Gauges shows the smoothness of filter effluent control.

This day after day performance of these controllers is typical; it is one reason why Builders Controllers have been selected for so many filtration plants, both large and small.

The same satisfaction is yours if you insist on Builders Water Works Equipment. Have you a copy of Bulletin 297?

BUILDERS IRON FOUNDRY
PROVIDENCE, RHODE ISLAND



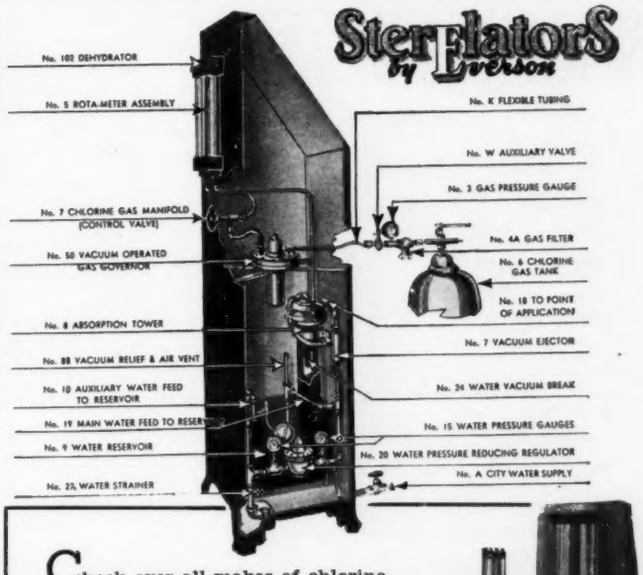
COAGULATE *with* PQ SILICATE

WATER WORKS in various sections coagulate with the aid of PQ Silicate of Soda to obtain clearer effluent, to increase rates of filtration, or both.

Seeing is believing when you make a laboratory test to observe these surprising results. Samples and advice are yours for the asking.

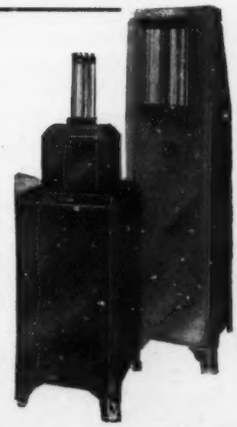
PHILADELPHIA QUARTZ COMPANY
General Offices & Laboratory: 125 S. Third St., Phila., Pa.
Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities.
Sold in Canada by NATIONAL SILICATES LTD., Toronto, Ont.

SILICATE OF SODA *SPECIALISTS*


SterElators by Everson
No. 10Z DEHYDRATOR
No. 5 ROTA-METER ASSEMBLY
No. 7 CHLORINE GAS MANIFOLD (CONTROL VALVE)
No. 5D VACUUM OPERATED GAS GOVERNOR
No. 8 ABSORPTION TOWER
No. 8B VACUUM RELIEF & AIR VENT
No. 10 AUXILIARY WATER FEED TO RESERVOIR
No. 19 MAIN WATER FEED TO RESERVOIR
No. 9 WATER RESERVOIR
No. 23 WATER STRAINER
No. K FLEXIBLE TUBING
No. W AUXILIARY VALVE
No. 3 GAS PRESSURE GAUGE
No. 4A GAS FILTER
No. 6 CHLORINE GAS TANK
No. 18 TO POINT OF APPLICATION
No. 7 VACUUM EJECTOR
No. 24 WATER VACUUM BREAK
No. 15 WATER PRESSURE GAUGES
No. 20 WATER PRESSURE REDUCING REGULATOR
No. A CITY WATER SUPPLY

Check over all makes of chlorine control equipment feature by feature, and you will agree with other competent engineers that EVERSON SterElators are the very last word, with: 1-Valve Control, Visible (calibrated) Rota-Meter, Automatic Gas Shut-Off, Automatic Synchronizing with Pump, Automatically Safe, (constant vacuum) protection of entire gas line, Far wider metering range and Multiplex Feed to 2 or more points.

Write for Bulletin No. 1004



EVERSON MFG. CO.
233 W. Huron St., Chicago, U. S. A.

SAVE TIME and TROUBLE

with this QUICKER HEALING Pipe Jointing Compound

Initial leakage heals quickly, Trenches need not stay open for days. Traffic hazards and inconvenience are quickly ended . . . all this when you joint your bell and spigot lines with Tegul-MINERALEAD ● Joints are easily made and permanently tight. No skilled labor, caulking or deep bell holes needed ● Tegul-MINERALEAD comes in 10 lb. ingots, easy to handle, ship and store ● No possibility of composition changing under jolting in transit ● No fear of rain, snow or flood, if stored in the open ● For more information, write The ATLAS MINERAL Products Company of Penna., Mertztown, Pennsylvania.

A Tegul PRODUCT

Tegul-MINERALEAD

MULTI-ZONE FURNACES

CONSTRUCT-DESIGN-SUPERVISE-ISS EAST 44TH ST.-NEW YORK-UNDERPINNING AND FOUNDATION CO.

For Incineration of SEWAGE SLUDGE, SCREENINGS, GROUND GARBAGE

Operation is without auxiliary fuel—odorless!

- SEPARATE DRYING AND INCINERATING ZONE.
- FLEXIBLE AND AUTOMATIC TEMPERATURE CONTROL.
- ALL GASES COMPLETELY DEODORIZED.
- RESIDUE UNIFORM, INERT, NON-OFFENSIVE ASH.
- OPERATING RESULTS POSITIVE AND LOW IN COST.

INSTALLATIONS AT
Niagara Falls, N. Y.
Milwaukee, Wis.
Lansing, Mich.
Raritan, N. J.

MULTI-ZONE FURNACES

Embody Greatly Improved Principles of Multiple Hearth Operation

UNDERPINNING & FOUNDATION CO., Inc.
155 East 44th St.
NEW YORK, N. Y.

EQUIPMENT NEWS

Improved Face Piece for M.S.A. Masks

● Wide vision, greater comfort, and added efficiency are advantages claimed for the new All-Vision Facepiece, announced by Mine Safety Appliances Company. It is U. S. Bureau of Mines Approved and becomes standard for all M.S.A. Gas Masks in the future.

In designing the new facepiece, extensive research was conducted to determine the most effective and practical design. The size and shape of the lenses is such that the wearer's entire normal vision is unrestricted without having extra glass surface to pick up reflections or add unnecessary weight. The dead air space has been reduced, thereby cutting down rebreathing of exhaled air, fatigue and lens fogging. The incoming air stream is directed over the entire area of the lens by means of a new type of deflector built integral with the facepiece. The design, selected after considerable experimentation, is said to provide a perfect gas-tight fit on all types and sizes of faces.

Another advantage claimed for the new M.S.A. All-Vision Facepiece is the elimination of "pressure points" that cause headaches and fatigue. This has been accomplished by making a moulded soft rubber facepiece that will follow the contour of the face, with minimum tension of the headband. The highly successful U. S. Army type exhalation valve has been retained.

For further details and prices write Mine Safety Appliances Co., 562 Oliver Bldg., Pittsburgh, Penna.

Dorrco Biofiltration System

● News of the month is the announcement of the DORRCO Biofiltration System, which the Dorr Co. is offering for sewage and industrial waste treatment as an economy producing, small spacetaking, and ruggedly dependable process.

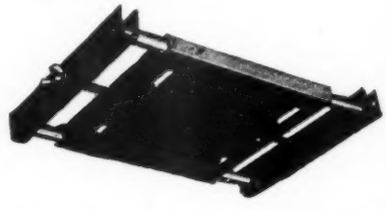
Biofiltration is the trade name applied to high-rate filtration, now developed to a degree of insured and dependable functioning. The high rate process already established in 12 installations (5 more under construction) involves recirculation of sprinkling filter effluent to dilute the applied sewage and allow sprinkling filter loadings of 10 fold those permissible with low rate application of undiluted settled sewages.

The Single Stage System provided with filter beds of but 3 ft. depth produces effluents comparable with chemical precipitation effluents. With deeper beds in series (Two Stage Systems) results are said to be comparable to Activated Sludge treatment, but with greater tolerance in respect to strength of sewage, its capacity and sporadic loadings so damaging to Activated Sludge in small to medium sized plants. First cost of Biofiltration Systems are claimed to run 25 to 35% less than the ordinarily trickling filter installation; combined operating and fixed charges, 30 to 40% less.

Compared with the Activated Sludge Process, space requirement and cost of installation is said to be approximately the same; but, combined operating and fixed charges, 30 to 50% less; plus the greater stamina in assimilating industrial wastes, peak loadings. In the Two Stage System of Biofiltration units may be placed one above the other where ground area is at a premium—such as at industrial plants, where the process would appear to have especial adaptability—perhaps conjunction with pre-chemical treatment to effect maximum overall effectiveness, economy and dependability.

New Motor Base Belt Tension Automatically Maintained by Spring Action

● A new, low cost Motor Base called the "Automatic", which automatically maintains correct belt tension through the action of special high grade steel springs is being offered by Ideal Commutator Dresser Co. of Chicago.



This unique design makes it especially suited to the favored short center drives. To take up slack in belts, operating in any position, it is only necessary to give the base adjusting screw a few turns. The base moves back instantly, giving the correct belt tension, maintained thereafter by the springs.

Installation is extremely easy, since the motor is mounted directly on to the sliding plate of the base. Utilizing this new Motor Base belts may be changed in 30 seconds, because it is simple to release the tension and re-establish it aftr the change.

If you have a motor-drive belt problem, write Ideal Commutator Dresser Company, 1615 Park Avenue, Sycamore, Ill.

"Simplex" Pipe Puller

● The "SIMPLEX" Pipe Puller is a recent addition to the very complete Templeton, Kenly line of "Simplex" Jacks so long manufactured (since 1899) and widely known. To meet the demand for pipe pullers, this piece of "Simplex" equipment supplements the "Simplex" Pipe Pusher described on this page about two years ago.

In these days of replacement of old services with flexible tubing, the most effective, least costly, quickest, and least damaging method is that of pulling through the tubing attached to the far end of the old service pipe. The job is preferably done from the cellar of the customer, but is frequently done at the curb or at the main, as here pictured.

Features of the "Simplex" Puller include (1) The "break-away" ratchet, seen in front. This turns the old corroded pipe and loosens it for subsequent easy pulling; (2) Pawl and rack lever action provides quick, positive backing out of pipe; (3) The Wedge Pipe Clamp operates on all sizes up to 1½-inch.

Of considerable interest is the moderate cost for the rig, complete for all jobs up to 1½-inch pipe, with slight addition for an extra Wedge Clamp for larger sizes.

For leaflet describing both the "Simplex" Pipe Puller and the "Simplex" Pipe Pusher, write Templeton, Kenly & Co., 420 Lexington Ave., New York City.

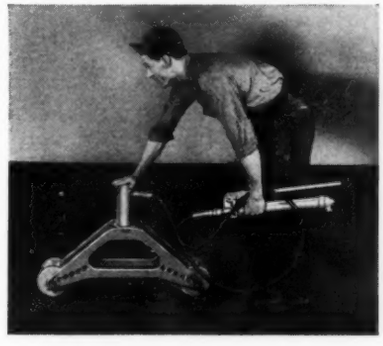
Improved Caution-Danger Signs

● A new caution-danger sign, to meet present day traffic needs in construction or repair work, is the HI-BOY Swing Sign announced by Industrial Products Co. of Philadelphia.

The new IPCO sign frame is suspended by a high free-pivot on each side to permit relief of wind pressure and, thereby, a standard which remains standing in high winds. When the standard is collapsed the legs fit within each other. Size of sign plate is 18x18 inches with standard black lettering on yellow enamel. Leg spread is 35½ inches for maximum stability and stands 45½ inches high in service. Sockets for two flags and a lantern hook are standard accessories.

For descriptive folder and prices write Industrial Products Co., 800 W. Somerset St., Philadelphia, Pa.

Improved Pipe Bender Handles Sizes Up to 4 Inches

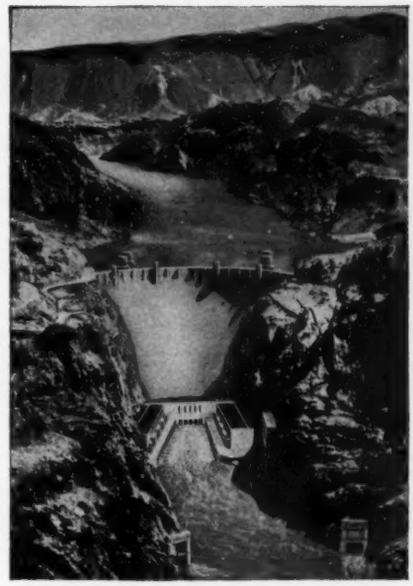


● The new "Porto-Power" Pipe Bender, by Blackhawk Mfg. Co. of Milwaukee, employs a small hydraulic power hand pump of 20-ton capacity to bend pipes, rods, etc., from 1¼ to 4 inches in diameter.

A smaller sized unit (10-ton capacity) is offered for bending tubular conduits, pipes, etc., up to 2 inches in diameter.

Both models are supplied in portable kits, the heavy model weighing only 190 pounds completed. They are applied to the pipe without need for wrenches or special tools to fasten the rotating "pivot shoes" in position. These so-called pivot-shoes serve as wheels when moving the benders from place to place. The hydraulic power pump can also be used for other purposes, such as gear pulling, lifting, pushing, etc.

For descriptive literature write Blackhawk Mfg. Company, Milwaukee, Wisc.



Bailey Meters AT BOULDER DAM

● In Boulder Dam Power Plant as in many other new hydro-electric stations including Madden Dam and Norris Dam, Bailey Fluid Meters are installed on hydraulic turbines.

At Boulder Canyon, the Bailey Meters measure water supply through 13 foot diameter penstocks under an average head of 530 feet. These meters indicate and record the water flow in terms of cubic feet per second and continuously integrate in millions of cubic feet. The registers are operated by pressure connections in the turbine scroll casings.

While your project probably does not entail the volume and head of water that is being measured at Boulder Canyon, it is nevertheless, important that your measurements of flow and liquid level be accurately made by reliable equipment.

Write for complete information on the application of Bailey Meters to your problem. MU-19

BAILEY METER • COMPANY •

1072 Ivanhoe Road, Cleveland, Ohio

BAILEY METER COMPANY LTD., MONTREAL

FERRIC
ISCO
CHLORIDE

For Sewage and Water Treatment have you tried

• ISCO •

Ferric Chloride . . . . .
SOLUTION or CRYSTAL?

FOR SLUDGE CONDITIONING—Ferric Chloride is accepted as the agent most efficient from the standpoint of performance and cost.

FOR COAGULATING SEWAGE—Ferric Chloride provides an inexpensive and effective method of dealing with plant overloads.

FOR WATER PURIFICATION—Ferric Chloride is an economical and practical coagulant, and gives quick-forming, fast-setting floc. Write

INNIS, SPEIDEN & CO.
117 LIBERTY STREET, NEW YORK, N. Y.
Chicago Cleveland Boston
Philadelphia Gloversville, N. Y.

FREE

A six day trial of an OK Sewer Cleaning Machine

Consider: We would be out of business long ago if the OK Sewer Cleaner did not sell itself under this offer for we have been merchandising one equipment under this plan for many years.

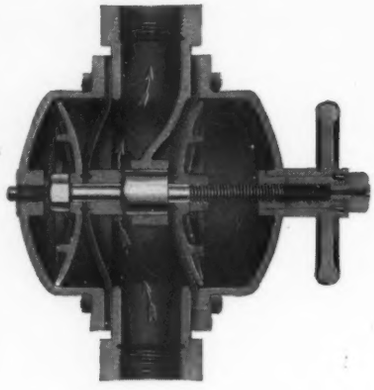
Under this plan you BUY—no high pressure salesmen at your elbow to force decision—the machine must meet the rigid requirements of your needs. And *you make the decision.*

You have nothing to loose—a favorable decision to accept the trial offer may save money, time and will assure service satisfaction.

Write today for Blueprint.

CHAMPION CORPORATION
4714 SHEFFIELD AVENUE
HAMMOND, IND.

A New Diaphragm Valve Especially Serviceable for Chemical Feed



● The development of diaphragm valves which are designed to control the flow of destructive or hard-to-handle liquids and gases has been announced by The McAlear Mfg. Co., of Chicago.

These valves are available in ferrous or non-ferrous construction and are glass-lined, rubber-lined or lead-lined, according to the service for which they are specified. They incorporate a diaphragm of pliable synthetic composition, which has exceptional resistance to acids and alkalies, hot or cold. Medium pressures and temperatures do not affect it. The resiliency of this diaphragm is greater than that of ordinary rubber diaphragms and this character permits the valves to shut off tight, even though particles of solid foreign substances should be trapped on the valve seat.

The ability to shut off tight also adapts these valves to vacuum service, and the absence of metal-to-metal contact when the valves close makes them well suited to service as non-pounding check valves.

The valves operate in any position in the pipe line and, because freezing temperatures cannot damage them, they are very practical for underground or outdoor installations. They may be operated by handwheel, upstream line pressures, hand levers or electric motors.

They are offered in single diaphragm type, with screwed ends, sizes 1" to 4" inclusive, and double diaphragm type (illustrated) with screwed ends, sizes 1" to 18" inclusive.

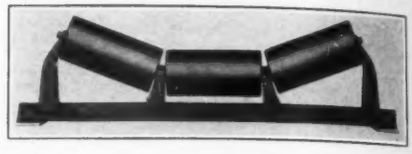
For further details concerning this diaphragm type of valve, which has proved so meritorious in water and sewage plants, write The McAlear Mfg. Co., 1901 South Western Ave., Chicago, Ill.

Midget 5 in 1 Slide Rule

● The midget is one of the circular pocket slide rules. It is 4 inches in diameter, constructed of white enameled aluminum and comes in both a fabricoid and leather case. Is reasonably priced, on money back basis. May be had from Tavella Sales Co., 25 West Broadway, New York City.

Improved Belt Idlers

● The improved "Series 43" Belt Idlers have recently been announced by The C. O. Bartlett & Snow Co. of Cleveland, Ohio.



Said to combine proven dependability and low first cost, these idlers have self-cleaning bases and the support brackets are assembled in jigs to assure proper alignment and correct spacing. Slotted holes are provided in the mounting plates to permit the making of any slight adjustments in aligning the belt. The idler rolls are machine faced on the ends and pressed onto the shoulders of the cast roll ends, whose outer edges have been rounded and smoothed to prevent injury to the belt. The free-running antifriction bearings are protected with Bartlett-Snow's efficient labyrinth grease seals, and a through grease tube is provided from one bearing to the other.

Details of these new idlers are covered in Bul. No. 80. For a copy write The C. O. Bartlett & Snow Co., Cleveland, Ohio.

Experienced Travelers Say!-

IN ST. LOUIS STAY AT
Hotel Lennox
DOWNTOWN, GOOD PARKING
GOOD FOOD AND REAL SERVICE
ALL ROOMS WITH BATH—RADIO RECEPTION

POSITION WANTED

By M. I. T. Graduate: Chemical Engineer. Age 42 yrs. Married. Experience—15 yrs. selling and executive duties, handling well known line of water works equipment. Also experience as water works superintendent; and qualified as sewage plant operator. References gladly furnished. "C. H. H." % Water Works & Sewerage, 155 East 44th St., New York City.

Sanitary Chemist—Desires position in a sewage or waterworks plant. Record—Chief Chemist of Chemical Treatment Sewage Plant, 2 years; Chemist and Bacteriologist for Illinois State Water Survey, 2 years; U. of Illinois graduate—B.S. in Chemistry; graduate in sewage—2 yrs. Age—28; married; available at once; go anywhere; reasonable salary.—Address "S.C.," c/o Water Works & Sewerage, 155 East 44th St., New York.

By Chemist—Operating water or sewage treatment plant or selling water works and sewerage chemicals or equipment. B.S. and M.S. in chemistry. Four and one-half years' experience as Sanitary Chemist in State Health Department. Address "D. J. J.," % Water Works & Sewerage, 155 East 44th St., New York City.

As Sewage Treatment Plant Operator. Four years experience as Chief Operator. Able to make all laboratory tests. Well acquainted with the mechanical and gasburning equipments. Not afraid of work or dirty hands. May I have the opportunity of attempting to fill your requirements. Can furnish the best of references both state and local. Address L. H., % Water Works and Sewerage, 330 S. Wells St., Chicago, Ill.

WITH THE MANUFACTURERS

Simmons Moved Up By Crane

● H. H. Simmons, advertising manager of Crane Co., has been promoted to manager of advertising and sales promotion. This deserved promotion comes after four years of service with Crane Co. However, Mr. Simmons brought to Crane Co. advertising and publicity experience gained over a period of 15 years.

Mr. Simmons, who is a director of the N.I.A.A., is actively interested in association work, having just completed a term as president of the Engineering Advertisers Association of Chicago.

P. J. McAuliffe Takes Charge of N. Y. City Office for Morris Machine Works

● Pierce J. McAuliffe has been appointed by Morris Machine Works of Baldwinsville, N. Y., to take charge of their New York City offices at 254 W. 31st St.

Mr. McAuliffe joined the Company in 1910, and at one time earlier had charge of the New York City sales office. More recently he has been connected with the home office in an executive capacity.

Peerless Pump Absorbs Kimball-Krogh

● From Food Machinery Corporation has come the announcement of the purchase of the Kimball-Krogh Pump Division of Victor Equipment Co. Kimball-Krough Pump Co. now becomes another Pump Division of Food Machinery Corp., along with its important Peerless Pump Division in Los Angeles.

The absorption of Kimball-Krogh Co. will enable Food Machinery Corp. to offer an entirely new line of pumps in addition to the well known and complete Peerless line of deep well pumps. The Kimball-Krogh line includes their newly developed sewage pump, a special horizontal centrifugal pump, drainage and irrigation pumps.

This announcement from Mr. Vernon L. Elder, Vice-President of Food Machinery Corp., which now has four pump factories, comes virtually on the heels of a major expansion in pump manufacture which involved the erection of a considerably larger and thoroughly modern factory and hydraulic testing laboratory in Los Angeles.

Davis to Service U.C.C. Combustible Gas Indicators

● According to a recent announcement, the Davis Emergency Equipment Co., 55 Van Dam St., New York City, manufacturers of detectors of dangerous and combustible gases, and other safety and first aid equipment, will henceforth service all U. C. C. Combustible Gas Indicators manufactured by the Linde Air Products Co. This service will include supplying renewal parts, making repairs, and supplying operating instructions for U. C. C. safety instruments.

Pitometer Company Territory Changes

● After 22 years of service with The Pitometer Company, A. E. Skinner, District Manager of the Chicago office, has been forced to resign because of ill health. "Al." plans to live in California, and we wish him a complete recovery.

Cyrus R. Bird, for some years Pitometer's Detroit District Manager, and immediate past-chairman of the Michigan Section of A.W.W.A., will take charge of the Chicago office. The Detroit office will be closed.

Homer E. Beckwith, District Manager, Harrisburg, Pa., is being placed in charge of a new office located in Pittsburgh, Pa. He will take over the greater portion of Mr. Bird's old territory, in addition to his present territory.

The above information has been released by E. D. Case, Vice-President and General Manager of the Company.

Allis-Chalmers Honors 38 Veterans

● *"We've Gone Places Together"* is the caption of a striking booklet issued by Allis-Chalmers of Milwaukee in honor of thirty-eight men in its employ for more than 50 years—one veteran having 64 years of service to his credit.

Richly printed in gold, blue-gray, and black, with a picture and biography of each of the thirty-eight men so honored, the booklet opens with a dedication signed by General Otto H. Falk, Board Chairman; Max W. Babb, President; and William Watson, Vice-President in Charge of Manufacturing.

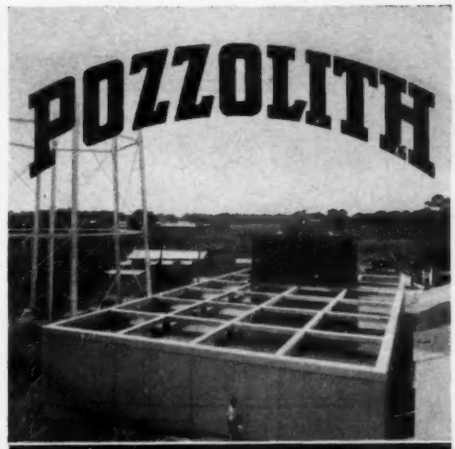
As guests of the Company, the men were presented with the booklets at a recent dinner and celebration held at the Pfister Hotel in Milwaukee. In addition to the booklet, each man also received a gold watch, appropriately engraved.

In honoring the 50-year men in this effective manner Allis-Chalmers refutes the oft-heard claim that industry is through with a man when he reaches forty. In public relations, this policy of A-C should prove a significant step. It will certainly spell security and happiness for A-C workers.

Hon. J. Henry Crane Heads American Centrifugal Pump

● American Centrifugal Corporation has recently elected Hon. J. Henry Crane as its president in place of Stuart Otto, resigned.

George E. Henkel, former Engineer in Charge of the Jamaica Sewage Treatment Plant of the City of New York, and more recently American's Chief Engineer, has been made a Director.



Seven Day Strength of POZZOLITH CONCRETE ... 5,139 Pounds Per Sq. Inch

The Pozzolith used has far exceeded our expectations," says Mr. C. Kenneth S. Dodd, Consulting Engineer on the Areator Basin, Sarasota, Florida. "I am so well pleased with it that it will be incorporated in all future specifications."

"I am recently in receipt of a test report for 7 day strength of 5,139 pounds per square inch on the cylinders taken from the floor in which the total water amounted to 4.5 gallons per sack, and the slump was five inches. Seven day strength specified was 1,750 pounds per square inch . . . The contractor is as well pleased with it as we are." Class A concrete. 1.5 bbls. cement per cu. yd.

Similar Pozzolith performance is available . . . send for it today . . . it tells how others are building more durable, watertight concrete, easily and economically.

SEND FOR THIS IMPORTANT TEST!

Freezing and thawing tests on Pozzolith concrete made by a leading university laboratory — authority in concrete research — show concrete durability is tripled by Pozzolith. Your copy of this report sent free upon request.

Send for full information to

THE MASTER BUILDERS COMPANY
Cleveland, Ohio

In Canada: THE MASTER BUILDERS Co., Ltd.
Toronto, Ontario

MASTER BUILDERS

Accuracy

The primary requirement of any metering device is its ability to accurately record and totalize flow rates over a wide range and with prompt response to any change in rate.

Only when all characteristics of both primary and secondary devices are known and properly related can this be done.

Purchasers of Simplex Venturi Tubes and Meters receive, in addition to mere equipment, the results of over 35 years continued studies and research on both the primary device and the meter register. With this knowledge incorporated in the equipment design, accuracies of any Simplex installation satisfy the most demanding requirements of designing and operating engineers.

Let Simplex Engineers show you WHY and HOW you can benefit.

SIMPLEX
VALVE & METER
COMPANY

6743 UPLAND STREET • PHILADELPHIA, PA.

MEETINGS SCHEDULED

Oct. 16-19—DALLAS, TEXAS (Adolphus Hotel)
Southwest Section A.W.W.A. Sec'y-Treas., Lewis A. Quigley, 3320 West Berry St., Fort Worth, Texas.

Oct. 17-20—PITTSBURGH, PA. (Hotel William Penn)
American Public Health Association. (68th Annual Meeting.) Exec.-Sec'y., Dr. Reginald M. Atwater, 50 West 50th St., New York City.

Oct. 18-20—ATLANTIC CITY, N. J. (Hotel Haddon Hall)
Pennsylvania Water Works Association. (Annual Meeting.) Sec'y., F. Herbert Snow, 507 Telegraph Bldg., Harrisburg, Pa.

Oct. 20-21—ATLANTIC CITY, N. J. (Claridge Hotel)
New Jersey Section A.W.W.A. Sec'y., H. N. Lendall, Rutgers University, New Brunswick, N. J.

Oct. 19-20—HAMILTON, ONT. (Royal Connaught Hotel)
Canadian Institute on Sewage & Sanitation. Sec'y-Treas., A. E. Berry, Ontario Dept. of Health, Parliament Bldgs., Toronto, Ont.

Oct. 25-26—SPRINGFIELD, ILL. (Leland Hotel)
Water Treatment Plant Operators' Conference. C. W. Klassen, Chief Sanitary Engineer, Dept. Public Health, Springfield, Ill.

Oct. 25-28—SAN FRANCISCO, CALIF. (Fairmont Hotel)
California Section A.W.W.A. Sec'y-Treas., Burton S. Grant, Civil Engr., Bureau of Water, Los Angeles, Calif.

Oct. 30-Nov. 1—OSHKOSH, WISC. (Hotel Raulf)
Wisconsin Section, A.W.W.A. Sec'y-Treas., Leon A. Smith, Supt., Water Dept., City Hall, Madison, Wisc.

Nov. 2-3—UTICA, N. Y. (Utica Hotel)
New York Section A.W.W.A. Sec'y., R. K. Blanchard, 50 West 50th St., New York City.

Nov. 6-8—CHARLOTTE, N. C. (Hotel Charlotte)
North Carolina Section A.W.W.A., Sec'y., R. S. Phillips, 206 Dacian Ave., Durham, N. C.

March 20-22 (1940)—TRENTON, N. J. (Hotel Stacey Trent)
New Jersey Sewage Works Association (Silver Anniversary). Sec'y-Treas., Paul Molitor, Jr., P.O. Box 374, Morristown, N. J.

Apr. 8-10—LEXINGTON, KY.
Kentucky-Tennessee Section, A.W.W.A. Secy., H. D. Schmidt, State Dept. of Health, Nashville, Tenn.

Apr. 21-25—KANSAS CITY, MO. (Headquarters Hotels—The Phillips, The President and The Muehlebach)
American Water Works Association Annual Convention. Secretary, Harry E. Jordan, 22 East 40th St., New York City, N. Y.

CATALOGS AND LITERATURE

"Peerless Pumps"—are, we would say, presented with *peerless* style and effectiveness in a new 64-page Catalog, handsomely and expensively produced. The new catalog covers the full line of Peerless Pumps, including water-lubricated turbines, oil-lubricated turbines, propeller pumps, mine pumps and the new Peerless "Hi-Lift" pump. Several pages are required to show the 10 different types and styles of turbine pump heads supplied by Peerless. These are illustrated with full details pertaining to water lubrication and oil lubri-

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cation of all models. Valuable hydraulic data fills the last 12 pages in the bulletin, while numerous installation views provide suggestions as to power hookup and methods of installation. With spiral binding, clever use of folded inserts, and hinged partial-page flaps (in 3 colors) makes this illuminating catalog one of unusual interest and effectiveness. Catalog No. 127-A is very much worth requesting. The address is Peerless Pump Division, Food Machinery Corporation, 301 West Avenue 26, Los Angeles, California.

"Instrumentation of Modern Sewage Works" is the theme of a new bulletin by The Foxboro Co. which features a schematic layout of a typical modern sewage treatment plant, with an indicating legend, revealing at what plant locations and stages of treatment various indicating and recording devices may be profitably installed. As the story of "Instrumentation" unfolds through the 16 pages, the several devices and instruments supplied by Foxboro for sewage treatment plants and pumping stations are illustrated and described with the schematic layout always visible to the reader. Instruments for indicating and recording flow, head, air pressure, vacuum, liquid level, temperature, and pH, are illustrated. Especial emphasis is placed on remote indicators and recording, and centralized control for convenience and economy. ROTAX Flow Control and Foxboro's air operated Stabilog System are also featured. For a copy of splendidly produced Bul. No. 232 write The Foxboro Co., Foxboro, Mass.

"The Story of TAPAX"—is the caption of a folder which describes the tape applied beneath manhole lids to stop manhole-lid rattle and bang which makes few friends for the responsible municipal department or the private utility company. TAPAX, and its simple application to reduce hazard and stop wear and tear on nerves and equipment, is described and pictured in kaleidoscopic fashion. The several sizes of the cushion-tape and prices are given. At the end, an imposing list of users. For "The Story of Tapax" write Tapax Mfg. Co., 201 Hoyt Avenue, Mamaroneck, N. Y.

"For Every Motor Pump a 3C Control", is the caption of a new four-page bulletin from the Clark Controller Co. of Cleveland, which pictures the latest developments in Clark Control Panels for modern water and sewage plants. Emphasized is the oversized elements employed in the design providing factors of extra safety and assured dependability of this important equipment. Many of the types of "3C" Control Panels illustrated have been installed in representative plants (named) and are completely described as to duties performed. Particularly interesting are the so-called "dead-front" units with swing out panels and anti-condensation features to preclude corrosion or arcing in sewage plant installations. Some of the "3-C" panels illustrated would seem to do everything but talk. For a copy of this bulletin, write The Clark Controller Co., 1146 East 152nd St., Cleveland, Ohio.

(Continued)

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"Rusta-Restor's Cathodic Process", for protecting steel water tanks against internal corrosion, is described in a brochure from "Rusta-Restor" Corporation of Freemont, Ohio. First discussed is the electrolytic theory of corrosion and how it proceeds between iron and natural waters to produce galvanic currents. To reverse the principle of the galvanic cell (battery) and convert the process of metal solution and oxidation (rusting) into an electro-plating process, of healing pits in the metal, the bulletin explains the basic mechanism of the electrical counter-flow method, now known as "Cathodic-Protection". It is an interesting exposition and discussion of the process of corrosion and its checking by the cathodizing process, for which "Rusta-Restor" equipment has been developed. For a copy of "The Electrical Method of Rust Prevention" write Rusta-Restor Corp., Fremont, Ohio.

"SIMPLEX Gauges"—to the extent of the manufacturer's complete line of types and styles, are presented in a new bulletin from Simplex Valve and Meter Company, boasting "35 years of specialized experience in meeting demands for rugged, accurate and simply maintained instruments." The new bulletin contains a sketch of a typical modern filter plant, showing the several locations of controllers, gauges and metering instruments. A key directs the reader to the instruments illustrated and described in detail elsewhere in the bulletin. Such include Loss of Head, Rate of Flow and Elevation Gauges, in several styles and 18 types of indicating and recording dials; Illuminated (large dial) Gauges for operating galleries. Many pictures of actual installations in 18 of America's most modern plants add interest. For Bulletin No. 78 write Simplex Valve and Meter Company, 68th and Upland Streets, Philadelphia, Pa.

"Permutit Pressure Filters", are presented in a rather complete bulletin from The Permutit Co., which describes and illustrates the latest improvements in Permutit Pressure Filters—including the Deflector Plate Distributor, Expansible Strainer Heads, and Group Control of the filter units, through adaptation of the "ambidextrous" Permutit Multi-Port Valve. An interesting filter unit pictured employs no strainers; no distribution laterals. Filter specifications and tabulated data are given for various sized units. For Bulletin No. 2225, write The Permutit Co., 330 W. 42nd Street, New York City.

"Air Compressors—By Schramm" is a new 22-page catalog distributed by Scrramm, Inc., which presents the very complete line of Schramm "Utility" Portable Compressors. In this catalog are illustrated the many models, equipped with gasoline or Diesel engine drive, in capacities of 85 to 420 cu. ft. per minute. An exceptionally complete assortment of portable mounting types are shown for all sizes. Operating data and detailed specifications supplement the picturized features, which include automobile push-button instant starting, electric generator for job lighting, the fuel saving Schramm slow-down adjustment and automotive type mechanical intake, pilot valves with a single moving part, overall

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"General Service Motorpump" is Ingersoll-Rand's complete pumping unit with built-in motor, without couplings or base plate. It is described and pictured in a most interesting manner in a new folder, which reveals the innards of the I-R "Motorpump" at a glance. These pumps have capacities of from 5 to 1000 gals./min. against heads up to 500 ft. The unit construction involves impeller mounting directly onto the shaft of the motor. The entire unit is enclosed in a housing which requires no base plate or foundation and may be bolted down in any desired position—vertical, horizontal, upside down. For novel folder No. 1917, write Ingersoll-Rand Co., 11 Broadway, New York City.

"Pomona Jet Pumps", which have distinctly new features, are presented in a well illustrated bulletin from Pomona Pump Co. of California. These deep well jet pumps for "small purpose" water supplies, feature no moving parts down in the well. The pumping head at the top of the well forces a portion of the pressure water to the jet and venturi eductor (lift piece) down in the well. The water lifted by the eductor is "boosted" by the pump impeller at the top of the well. To avoid corrosion effects the jet is constructed of a moulded plastic and the venturi tube (the "heart" of a jet pump) is constructed with precision from wear resistant moulded rubber compound. For a copy of Bulletin No. 40 featuring "The Pomona Jet Pump", write Pomona Pump Co., Pomona, California.

"Picking the Right Valve" is a Crane folder which discusses the "Service Characteristics of Globe Valves and Gate Valves—How to Pick the Right One Every Time." A procedure is outlined for determining on the type of valve needed by first using the "Valve Selection Guide," which is an easy to follow chart which eventually leads the user to the proper section in Crane's Catalog No. 52, wherein more than 38,000 valves and fitting items are covered. The folder also presents helpful hints on piping arrangements, applications and maintenance of valves. A copy of "How to Pick the Right One Every Time" may be had from Crane Co., Div. of Water & Sewage, 836 So. Michigan Ave., Chicago.

"Chicago Pumps at Two World's Fairs" is the theme of a new Chicago Pump Co. folder, which boasts the fact that in the New York World's Fair are 53 installations of Chicago Pumps; in the San Francisco World's Fair—39 units. The folder features the very practical trouble free "Never Clog Flush-Kleen" installations for collecting and intermittently pumping crude sewage from buildings and collecting points on sewerage systems—large or small. Other Chicago products —such as Swing Type Air Diffusers, Comminutors and Mechanical Aerators are pictured also.

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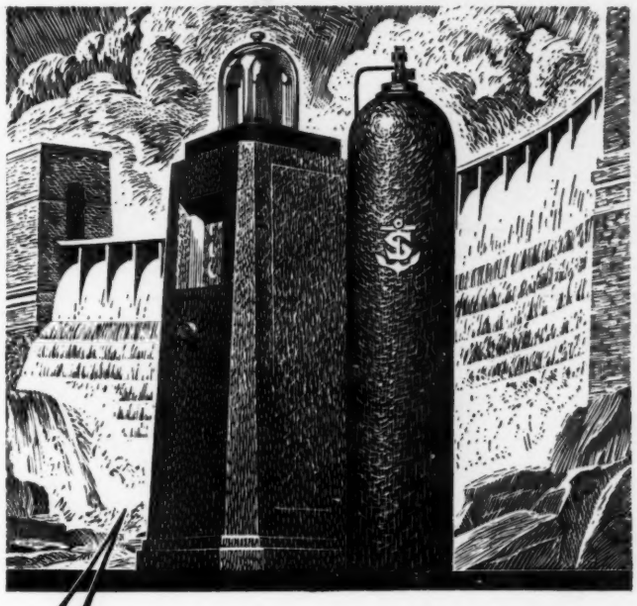

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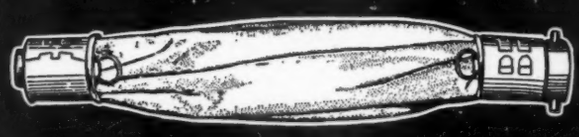

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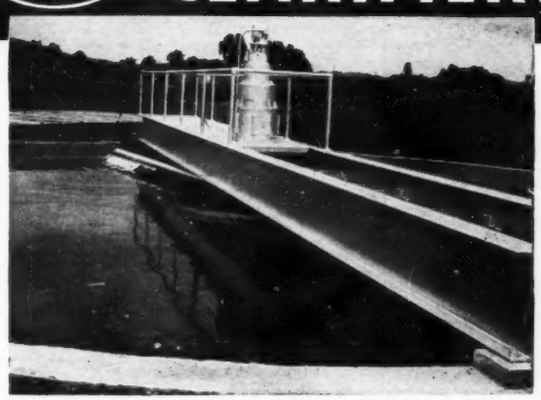

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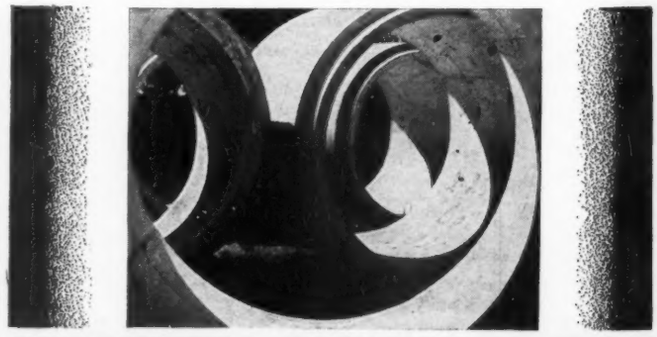

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▸ WHAT IT IS

The Biofiltration System comprises the combination of a Clarifier and a Trickling Filter wherein the Filter discharge is recycled back to the Clarifier which also receives incoming feed to the system. The recycled Filter discharge may consist merely of Filter effluent or of the effluent or sludge from a Secondary Clarifier following the Filter. Single or Multiple Stage Systems may be employed, depending upon the degree of treatment required.

▸ WHAT IT DOES

This System makes it possible for the first time to control completely the operation of a Trickling Filter. This means the ability to obtain a final effluent of substantially uniform character, despite wide fluctuations in the volume and composition of the feed. Furthermore, it permits filter loadings up to ten times those normally employed and the use of shallow filter beds having filter media depths as low as 3 ft.

The Single Stage Biofiltration System gives results substantially the same as standard Trickling Filter practice. A modified, Single Stage System gives results approximating chemical precipitation. The Two Stage System not only gives results comparable with activated sludge treatment, but also gives uniformly satisfactory effluents on unusually strong sewages.

▸ WHERE APPLICABLE

This new system is directly applicable to new plants where better than primary treatment effluents are required, or to existing trickling filter or activated sludge plants which are overloaded. Unusual advantages attend its use where industrial wastes are present or where the feed varies widely in volume and composition.

▸ WHERE USED

12 Biofiltration System plants are now in operation, ranging in design capacity from 0.05 to 3 m.g.d. In addition, 5 other installations are under contract or construction at this time. Names will gladly be given on request.

▸ ADVANTAGES

Compared with Standard Trickling Filter Practice—

- Installed cost 25 to 35% less.
- Operating cost, including fixed charges, 30 to 40% less.
- A smaller and more compact plant per unit of design capacity.
- Uniform results regardless of feed fluctuations.
- Filter fly and filter pond nuisances eliminated.

Compared with Standard Activated Sludge Treatment—

- Installed cost approximately the same.
- Operating cost, including fixed charges, 30 to 50% less.
- Substantially the same overall plant area.
- Expert supervision not required to maintain high plant efficiencies.
- Industrial wastes, not amenable to activated sludge treatment, readily handled.

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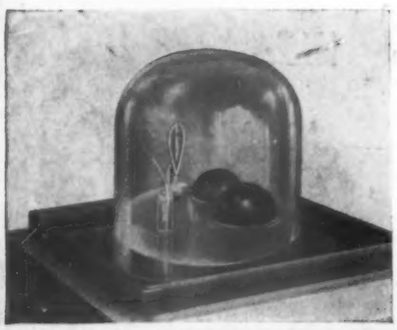

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